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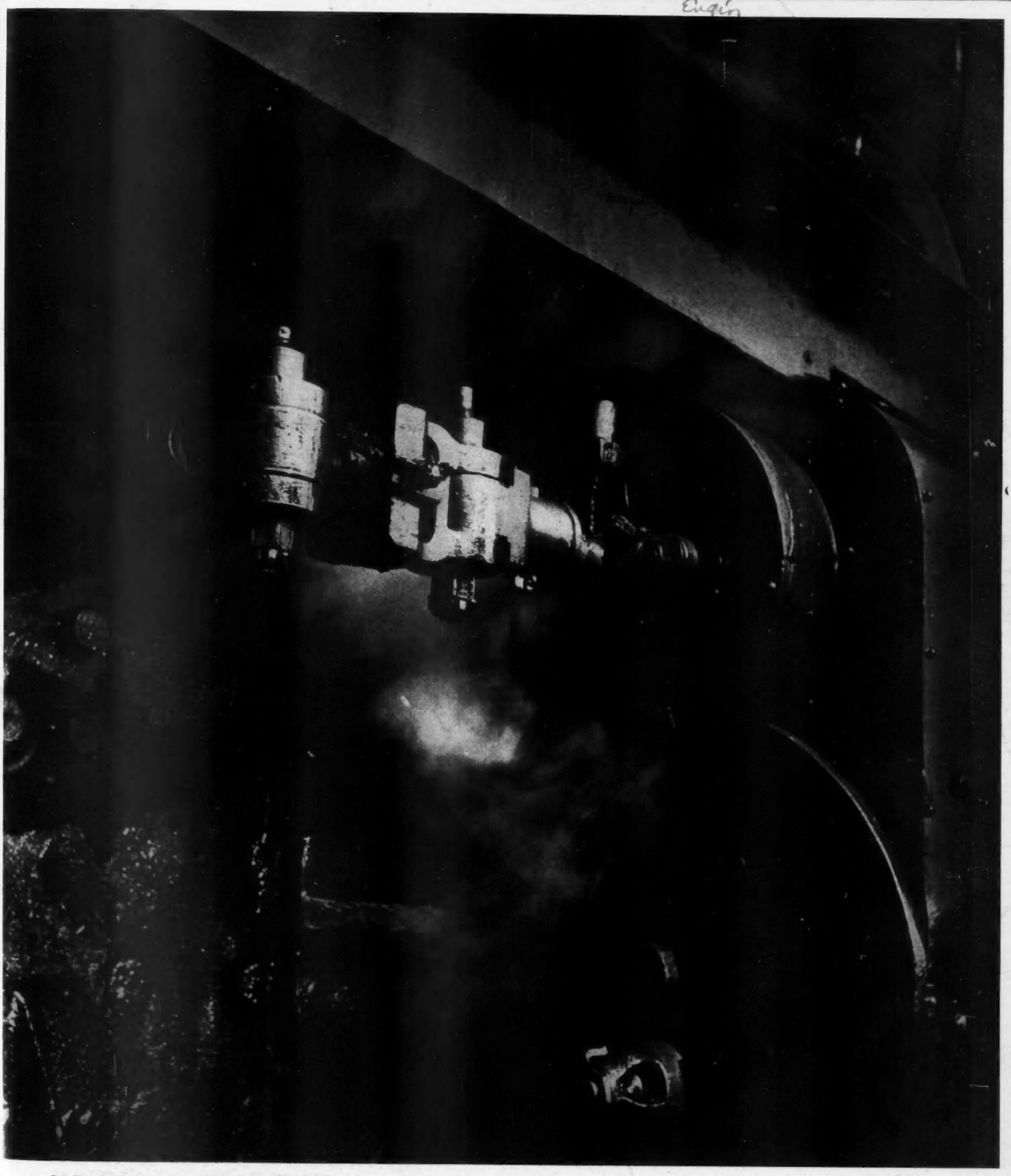

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Leading Article
Developing a Design 713

Weekly Survey
Henry Ford II and British Cars 714
Northern Ireland Seeks Industry 714
Encouragement from the U.S. 714
Lorries and Buses doing Well 714
Fears for Instruments 714
An Engineer Honoured 715
Replacement of Ships 715
Sandwich Courses 715
Anglo-American Transport Aircraft 715
Thinking of the Future 715

Principal Articles
The Russian Steel Industry: Output and Earnings 716
What are a Pound and a Yard? Imperial Standards In Question after 100 years 718
Long-Range Flights between City Centres? Principle of the Jet Flap 722
Testing the Reliability of Complicated Machines: A Method to Limit Prototype Trials 723
International Flame Research: Inauguration of Pulverised-Fuel Furnace 726
Instrumentation as a Service: Designing and Building Automatic Control Systems 728
The Iron and Steel Institute: Lean Iron Ores 729
Draining a Water-Surrounded Power-Station Site: Wellpoints adopted at South Denes 730
Timber for Machinery: Arduous Uses 732
Preserving Timber: Prevention of "Soft Rot" 732
Poke Welder: Welding in Inaccessible Areas 733
Free Piston Gas Generator 733
U.S. Navy's Guided-Missile Carrier Commissioned 734
Sound Reproducing and Marine Radar Equipment: Display of Apparatus 734
De-Watering and Filtering: Plant for Mines and Chemical Works 735
On-Load Transformer Tap-Changer 735
Flameproof Gate End Panel: General Purpose Control Switch for Mines 736
British Civil and Military Aircraft: Review 737
The Beama Dinner 737
Supporting the Roof of an Advancing Coal Face 738
Automatic Electric Control Gear 739
Radio Relay Systems: Multi-Channel Problems 739
Orthodox Engineering at Calder Hall 740
Ljungström Turbine: Set Presented to Makers 740

Obituary
Col. N. T. Belaiew, C.B. 719
Mr. E. H. Ford, O.B.E. 719
Mr. N. C. Bridge 720

Book Reviews
The Foreseeable Future 720
Dynamics of Machinery 720

Notes
Bevel Gear Cutting Machines: B.G.M.A. meeting 717
Work of the B.S.I. 717
Titanium Production 718
National Aeronautical Establishment, Bedford 727
A Surface Grinder Improved 728
Oxygen by Pipeline 731
Gas Flow Recorder 733
Friction-Grip Conveyor Belt 733
Short-Range Radiotelephone 736
Portable Cathode-Ray Engine Indicator 738
Danish-Norwegian Telephone Cable 739

In Parliament 743

The Human Element 744

Personal 719, Commercial 719, Contracts 719, Books Received 721, Trade Publications 721, Launches and Trial Trips 737, Forthcoming Exhibitions and Conferences 741, Notices of Meetings 742

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DEVELOPING A DESIGN

A WELL-KNOWN engineer recently told the story of how he joined a world famous firm as development manager and was promptly faced with trying to commission a prototype plant, worth a quarter of a million pounds, designed under his predecessor. He found that both in quantity and quality the design effort that had gone into it had been less than he himself had recently considered necessary to devote to the design of some new machinery costing a mere £20,000, and privately he doubted whether it ever could run satisfactorily. After some months spent in eliminating obvious fundamental errors, he found that neither the performance of the plant nor the quality of the products from it appeared to improve; so he asked for a new manager to be appointed. Now the new man was no abler technically than his predecessor, but he was a great enthusiast, and he soon had every man on every shift not merely fully conversant with what was his individual job, but imbued with the determination to make the plant a success. Within a month it was.

This reminiscence was inspired by an article written by an I.C.I. research man, Dr. G. Morris, which we publish in this issue. It tackles the problem of limiting the cost of prototype trials, a problem which every board of directors views with concern, and which has caused chief engineers and development managers many headaches and much worry. The difficulty of making reasonable decisions as to how long trials shall continue tends to rest on two separate categories of troubles—the quality of the product that the machine has been designed to produce, and the reliability of the machine; and whereas scientific aids to the analysis of the questions raised by the former have long existed, until now we have never heard of any methods that helped in the latter. Dr. Morris's method has been tried out in practice and seems to be as simple as could be desired. His idea is to collect data on the faults as they occur during development and to analyse the data so as to indicate the stage at which further trial and development serves no useful purpose so far as reliability is concerned. He has found that the faults can generally be placed in one of two families, the first of which diminishes as development proceeds and the second of which constitutes the inherent faults of the machine, which cannot be eradicated by reasonable development.

The problems of analysis of the quality of the products have long rested on the sure and certain foundations laid by the statisticians. The essentials of these were made available in non-mathematical and readily usable form some 20 years ago by the publication of B.S.600, entitled "Quality Control," and some of the more recondite techniques were similarly made available in 1949 in a volume called "Industrial Experimentation," published by the Stationery Office at a negligible price. Despite these attempts at popularisation (and the Penguin book by Mr. M. J. Moroney called *Facts from Figures* must also be mentioned), all too few firms make intelligent use of the elementary concepts of probability and the laws of chance, let alone such powerful weapons as the study of standard deviations and the use of t-tests. Often the reason given by a director, if pressed for an answer, is that you can prove anything with figures, and that he does not believe the statisticians; yet he will then proceed to take decisions on the figures in front of him which are equivalent to saying that there are more heads than tails on pennies, because a handful laid on the table show more of one than of the other.

The parable of the talents has rarely been more applicable to any situation than to that in industry to-day. The firm which is capable of using, and uses, the analytical tools that lies ready to hand is also the firm which is capable both of forging itself new tools when they become urgently necessary and of using those displayed to it by others. Such firms know, however, that there is no way of avoiding sweat and toil and disappointment in development work, but only methods of scaling each peak more rapidly so that the next may be attacked. They do not expect of scientists or professional engineers that they shall be magicians, and they will not expect them to find a magician's wand in any new method, however promising it may appear to be.

Dr. Morris, in his paper, has started to do for the analysis of machine and process failure what the statisticians have done for the analysis of the quality of the product, and the possibilities which these ideas may hold appear to be enormous, not merely in saving money on development, but even more of saving unnecessary waste of the time of precious development engineers—a commodity rare in this country. It is greatly to be hoped, therefore, that more firms may be prepared to contribute the experience of development work pleaded for in this paper. We know that Dr. Morris has already received evidence of the value of his method in the form of several private communications in advance of the publication of his article. There must be many other records which could be used to test the validity of his method. Perhaps, too, there is another method of arriving at the same result. Either way, actual case histories (stating the type of machine wherever possible) would be convincing and would help to establish Dr. Morris's method as a valuable analytical tool.

Weekly Survey

Cover Picture: *No student of locomotive design will need to be told that the photograph on the front cover this week shows a characteristic detail of a Great Western Railway locomotive—the drive to one of the outside valves. The engine is No.* 4000, *"North Star", of the Castle Class.*

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Henry Ford II and British Cars

The recent visit of Mr. Henry Ford to this country and his remarks to the Press lent a fresh impetus to the controversy now raging on whether or not British car manufacturers can expand their exports in step with their expanding production. Not in the United States, said Mr. Ford, but elsewhere certainly. The sellers' market has gone in North America, yet the U.S. manufacturers go from strength to strength. In the first nine months of this year, they sold nearly 6 million cars—an annual rate of 8 million. There seems to be no limit to the capacity of the American public to absorb cars, so why not a proportion of British cars? There is no evidence that British manufacturers share Mr. Ford's pessimism as to their U.S. export prospects. Certainly Mr. Nordhoff, head of Volkswagen, does not. In the first half of this year, his company sold 10,000 cars in the U.S.—five times more than a year previously. Volkswagen have bought for 4 million dols. the Studebaker-Packard factory in New Jersey and expect to part-make and sell 75,000 cars. Yet sales of British cars have dropped from 20,870 in the first nine months of 1954 to 15,800 in the same period this year. There may be something in Mr. Ford's remarks after all.

Henry Ford II is a remarkable man at the head of a remarkable concern, which has an output of well over 2 million vehicles a year from 15 assembly plants, the largest of which—the Rouge plant—can turn out 9,000 units a day. When he took over the direction of the Ford Motor Company in 1943, at the age of 25, it was a tottering enterprise. Mr. Peter F. Drucker in his latest book, *The Practice of Management*, writes that the company had been brought to the edge of collapse by the misrule of Henry Ford I. Their share of the market had fallen from two-thirds in the early twenties to one-fifth when the war started: "Fundamental to Henry Ford's misrule was a systematic, deliberate and conscious attempt to run the billion-dollar business without managers." His grandson got rid of the rigid centralisation and the "secret police." He became head of a team of managers each with his own responsibility for the policy and the running of his share of the business. The effect of what Drucker describes as a radical reversal of policy has been the pressing challenge which Ford are now making to General Motors' supremacy, "one of the epics of American business." The man who came to the business without experience has learnt to use the experience of others and proved conclusively the value of team work in big business.

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Northern Ireland seeks Industry

Lord Chandos, chairman of the Northern Ireland Development Council, said that its function was to persuade industrialists in Great Britain, the United States, and elsewhere, to take advantage of the 26,000 unemployed and set up plants or factories in Northern Ireland. The country has no coal or iron ore but plentiful water and very good labour. There are freight problems but in his view they are more than compensated by the considerable financial assistance given by the Government and by the possibility of utilising machinery more fully through shift work. Speaking of the experience of the British Thomson-Houston Company, of which he is the head, at their Larne turbine factory (Weekly Survey, September 30), Lord Chandos said that the Northern Irish were keen and loyal workers, able after a short period of training to turn out "a high-grade technical product with great success." The Council intend to publish figures which show that output per head is as high and, in quite a number of cases, higher than that which is found in corresponding plants and in similar processes in Great Britain. Over 100 new factories now employing 25,000 people have been uniformly successful and 75 have implemented schemes of expansion. Among the newcomers are companies of international repute, such as Courtauld's, the Metal Box Company, Triang Toys, Lotus Shoes, Nestlés, and B.T.H.

The Development Council, whose members include Sir Ewart Smith, deputy-chairman of I.C.I., and Mr. S. C. Leslie, seconded by the Treasury where he was head of the Information Division, will publicise the facilities which exist, advise companies which show interest and so help to quicken a process of industrial growth that has been going on during the past ten years. Asked about Mr. Harry Ferguson's intention of setting up a car manufacturing organisation in Northern Ireland, Lord Chandos said that the scheme was so large and required so much labour and capital that only part of it could be accommodated. He also mentioned that atomic power stations could go far to solve the country's fuel problems and that he was personally to discuss the matter with the Atomic Energy Authority. More abundant and cheaper power would be a considerable asset to Northern Ireland, and the prospect of it could be a most effective attraction.

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Encouragement from the U.S.

The White House has acted with encouraging speed in the controversy that still surrounds the award of major United States contracts to foreign firms. Four contracts for electrical distribution plant were awarded to British, Italian and Swiss manufacturers who underbid their American competitors by more than 12 per cent. English Electric are to supply the distribution transformers (£37,177), Industrie Elettriche di Legnano the auto-transformers (£90,400), and Brown Boveri the power circuit-breakers (£48,000). But all the American companies who lost the contracts had labour surplusses in their area, and President Eisenhower's liberalised "Buy American" Executive Order issued last December called for a foreign company being awarded a contract if its quotation is 6 per cent. or more below the lowest American price and if the American company is not in a surplus labour area.

In this case, therefore, the contracts could have been awarded to American manufacturers. The fact that they were not suggests that the United States Government are serious in their intention to liberalise trade, and this should go some way at least to allay British fears that it is useless to quote for anything big in the United States. There will certainly be opposition from interested parties but it is becoming clearer that President Eisenhower's declared intention to press hard for a liberalisation of world trade is meant for internal as well as foreign consumption. Another lesson to be learnt from them is that British companies making products with a high labour content stand a very good chance of competing successfully in the United States.

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Lorries and Buses Doing Well

The production of heavy road vehicles has increased substantially this year and most of the builders report a much healthier order book than a year ago. The output of lorries over 6 tons load capacity during the first eight months of the year was nearly 4 per cent. higher than a year ago, and that of buses 15 per cent. higher. The improvement has been most marked in the "heavy" section of the industry. Leyland Motors have raised output by about a quarter over the past two years, two-thirds of which is being exported. Associated Commercial Vehicles report a 30 per cent. increase in orders booked, with over half the output being exported. Other companies in the industry, such as Guy Motors, Dennis Brothers, Fodens and Atkinson Lorries, are experiencing a similar rise in demand.

The ability of British heavy-vehicle builders to compete successfully overseas has been in evidence since the war but they fear that another round of wage increases may prejudice their position. They are also most concerned with the shortages of certain materials, particularly rolled steel sections and alloy steels, which may prevent them from adhering to their delivery schedules and certainly from further raising output.

Heavy-vehicle builders who are also engine manufacturers—of industrial and marine as well as automotive and railcar engines—have been most successful in finding new markets overseas. Leyland have recently negotiated a contract to supply a Dutch firm with 1,000 engines a year; A.C.V. have brought out a new range of Diesel engines from which a great deal is expected, and have just completed a major re-organisation of their engine workshops at Southall at the cost of £200,000. An output of 150 engines a week will be possible under the new arrangements. This is practical evidence of the confident outlook of heavy-vehicle builders, and will go far to offset any increases in wages rates that are granted.

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Fears for Instruments

Foreign competition came in for a good deal of notice at the Scientific Instrument Manufacturers' Association meeting at Eastbourne recently. Particular concern was expressed at the rapid growth of German competition and also at the possibility that the tariff on imported scientific instruments might be reduced.

The scientific instrument industry consists mainly of small companies. According to the Census of Production return for 1950 there are nearly as many concerns employing 10 or fewer persons as there are employing more than 10. The value of its production has increased notably of recent years. Its estimated gross output for 1950 was £72 million, compared with less than £11 million in 1935. Its net output per person employed has increased over 15 years between 1935 and 1950 from £225 to £533 and its average employment figure in 1950 was just over 79,000.

The external trade figures for the last year or two are interesting. Exports of all classes of scientific instruments in the first half of this year were valued at £17·3 million, compared with £15·6 million in the first half of 1954 and £13 million in the same period of 1953. Exports have thus been rising steadily, particularly to the Dominions and larger colonies. It is important to remember, however, that this industry is especially vulnerable to any import restrictions which Australia may impose on its products, since that Dominion accounts for about 20 per cent. of its total export market. The only large Dominion which has not shown resilient business has been Canada, where imports of scientific instruments from this country have been declining steadily over the last three years. So far as imports into this country are concerned, these have also been on the increase. The outstanding feature has been the progress made by Western Germany and the United States. Imports from Western Germany have gone up almost three times in the last 3½ years, and in the first half of the current year they accounted for 20 per cent. of total imports. Scientific instruments from the United States have doubled over this period, to account for 27 per cent. of the total between January and June this year.

With Western Germany out of the world market for so long the British industry was bound to have a unique opportunity of developing its home and export markets. The indications are that it has taken good advantage of these favourable circumstances and it is to be expected that the return of Germany to the export market will increase both the quantity and the quality of the competition. The basic issue of policy to be decided may soon be as to how far British

industry should be dependent for certain kinds of instruments on foreign sources in an age when instrumentation is on the increase. So far since the war, the British scientific instrument industry has found itself able to meet competition at home and abroad overall; it will be a nice calculation to decide how far competition might be allowed to go before the British industry operated at a definite disadvantage.

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An Engineer Honoured

Few engineers achieve such recognition that a memorial is erected in their honour. One of the few was remembered recently at a ceremony in Ottawa, Canada, when a tribute was paid to Lieutenant-Colonel John By, R.E., builder of the Rideau Canal and virtual founder of the Dominion's capital city, which was formerly known as Bytown before it was renamed Ottawa just 100 years ago, in 1855. The ceremony, on October 5, was organised by the Engineering Institute of Canada and the unveiling performed by the President of the Institute, Dr. R. E. Heartz.

The memorial is a red-granite fountain located on the Driveway, beside the Rideau Canal. The fountain played for over 100 years until 1948 in Trafalgar-square, London, and was designed by Sir Charles Barry (1795-1860), famous as the architect of the Houses of Parliament. When it was replaced by a larger fountain, it eventually became available to the Institute for dedication to Colonel By.

John By was born in London in 1779 and was educated at the Royal Military Academy, Woolwich, receiving his commission in 1799, first in the Royal Artillery but transferring to the Royal Engineers later that same year. He was stationed in Canada from 1802 to 1809 and returned to that country in 1826 on his appointment as superintendent of construction of the Rideau Canal. In addition he was also required to serve as first magistrate for the new community of Bytown; he surveyed the area, rented lots to the settlers, built streets, made regulations on the building of houses, established a school and dealt with contractors' claims. But he always had in mind the ultimate role of the canal. He wished to keep the navigation inside British territory not only "to deprive the Americans of the means of attacking Canada" but also "to make Great Britain mistress of the trade of that vast population on the borders of the Great Lakes which would serve as so many outlets for British manufactured goods."

For his labour and foresight he received no special recognition from either the Government or the Army and he died in England at the age of 56 in 1836, four years after the canal was officially opened. Now his name will be perpetuated by the memorial which, like the man, links Canada and Britain.

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Replacement of Ships

Controversy still surrounds the proposed terms on which the Union-Castle Mail Steamship Company, Limited, may merge with Clan Line Steamers, Limited. We are not concerned here with the financial terms of the suggested scheme, but there is little doubt that the problem of building new tonnage has had a vital influence, especially on Union-Castle's attitude to the scheme. The proposed new holding company, British and Commonwealth Shipping, Limited, which would control both operating companies under the new scheme, has made it quite clear that the combined resources of Clan and Union-Castle would make it easier to obtain finance to maintain the fleets. The total estimated cost of replacing the two fleets would be about £161 million. At current prices Union-Castle would have to spend £51 million on replacing ships which will be at least 25 years old by the end of 1964. On the other hand Clan would need to spend only £8·6 million, so that the problem is much bigger for Union-Castle. Under the recently renewed ocean mail contract with the South African Government, three new mail vessels, one of which has already been ordered, will be required to replace vessels now 25 years old or more, and this item alone will cost £20 million. The holding company points out that all existing liquid resources, together with substantial retentions from future earnings, will be required to finance the future building programme of Union-Castle. It is clear that the advantage of the merger, viewed from this side of the problem only, is the immediate comparatively greater earning capacity of the Clan ships and the much less urgent replacement problem for Clan Steamers.

If this marriage of convenience takes place (celebrated may hardly be the appropriate word in this context)—and it seems highly likely that it will—two of the largest shipping concerns in the country will have been brought together almost entirely for financial reasons. There is nothing intrinsically wrong with such an arrangement and it is the kind of move which can become fashionable as a means of rejuvenating conservative boards. If it should occur, care will have to be taken to ensure that the organisations concerned can work together and adjust their methods and traditions to one another. No matter how determined those in control may be that the operating companies which become financially inter-linked by such arrangements shall maintain their own identity, the way is being paved for an eventual complete amalgamation. In shipping, some of these amalgamations in the past have been swift in effect and in others individual identity has been and still is maintained. Now is the time, however, to point out that a potent factor may be developing to influence seriously the organisation of the British shipping industry in the second half of this century.

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Sandwich Courses

According to some information recently given in the House of Commons by the Minister of Education, there are at the present time 41 technical colleges in England and Wales which are operating sandwich courses in engineering and other technologies, of which 35 have courses leading to qualifications of at least Ordinary National Certificate or Diploma standard in engineering, applied physics or metallurgy. None of these courses was in existence before 1949, and most of them have been started since the academic year 1954–55. In that year 1,522 students were taking these courses at different levels of qualification and, no doubt, the figure is a good deal higher this year. It compares with a total of 25,145 entrants for the Ordinary National Certificates, and Diplomas and 10,054 for the higher awards in 1954.

There is evidently a long way to go before an appreciable proportion of non-university technical education takes place other than by evening classes or one-day release from employment, but the accelerating pace of this development is encouraging. It obviously owes a great deal to the co-operation of a number of progressive firms, chiefly in electrical engineering. There is, for example, close co-operation between Metropolitan-Vickers and Salford Royal Technical College, between G.E.C. and Birmingham College of Technology, between B.T.H. and Rugby College of Technology and between de Havilland and Hatfield Technical College. Elsewhere colleges are supported by groups of smaller firms. A number of colleges are providing courses in production or industrial engineering or in management studies.

There is a danger in the unco-ordinated spread of these courses that the shortage of teachers of good enough quality may dilute the standards of teaching and prevent the development of a number of colleges into institutions concentrating on higher grade work and research. On this matter the report of the Technological Awards Council, under the chairmanship of Lord Hives, should have a good deal to say. It is therefore disappointing that the Minister of Education should have stated in the House of Commons last week that the other members of the Council have not yet been appointed, although the original announcement of its formation was made as long ago as July.

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Anglo-American Transport Aircraft

The joint announcement by the Bristol Aeroplane Company, Limited, and the General Dynamics Corporation of the United States that Bristol, Convair and Canadair are to collaborate, in the first place on a joint specification for a new ultra-long-range transport aircraft, designed around four Bristol BE25 turbo-propeller engines, will surely be welcomed by the British tax-payer, who has in the past 10 years seen so many million pounds dissipated on British airliner projects that, for one reason or another, have fizzled out. The American aircraft industry has for so long held a monopoly in long-range transport aircraft that the prospect of even breaking into this market with British machines is not an easy one, particularly as the development resources of the British aircraft industry are already overloaded. It seems, then, commonsense to combine the experience and resources of the American transport-aircraft builders with the superiority of the British gas-turbine engine.

The new Bristol-Convair-Canadair project, it is stated, will be able to operate non-stop across the Atlantic in both directions at all times of the year. The intention is that the aircraft and engines shall be produced concurrently on both sides of the Atlantic. A combined engineering group working at San Diego will complete the technical specification in January, when a further statement will be made.

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Thinking of the Future

Sir Ivan Stedeford, chairman of Tube Investments, Limited, has reviewed the next phase of the unending industrial revolution in his annual statement sent out with the company's accounts. This new age, according to Sir Ivan, constitutes a three-fold attack on traditional industrial practice, each one of which is as significant in its way as the introduction of the steam engine or the factory system were in the Eighteenth Century. The first line of advance is the development of synthetic materials, a development in which this country has long excelled. The second is the application of atomic energy and the by-products of nuclear fission to domestic uses. In this he thinks that this country is probably in the lead in important respects. The third line of advance is the development of automatic machines and instruments, and on this Sir Ivan inclines to the view that we prefer a slow rate of development.

His own company has been trying to condition itself to these scientific and technical changes and to derive full benefit from them. There has been a notable expansion of Tube Investments' scientific and technological research resources, and further laboratories are being constructed which will include facilities for the study of the by-products of nuclear fission. Progress has also been made with the development of a technological department which will develop the practical application of new techniques and materials of value to the company up to the prototype or pilot production stage. Part of this department is a control engineering section which will develop the application of automatic operations in the company's factory.

Developments on this scale by a large company emphasise the need to-day for considerable capital resources, diversification of products and large markets for many of them. While it is true that technological progress, including automation, will lead to lower costs of production if correctly applied, and so to bigger markets, the inverse is also true. Large outlets are necessary to justify the heavy investment which is demanded of the metal and engineering industries. There is a vital cycle of exports, investment and the home market for most big engineering concerns, and prosperity depends on the increasing pace at which this cycle can be sustained.

THE SOVIET STEEL INDUSTRY

ECONOMIC CONDITIONS AS REFLECTED BY OUTPUT AND EARNINGS

In a report on a visit by a team of specialists to the Soviet Union (see* ENGINEERING, *September 23, page 405, 1955), Sir Robert Shone, C.B.E.† recently assessed the strength of the Russian economic position in relation particularly to the steel industry, and the industrial methods employed in furthering its progress. This he did under three main headings: productivity and incentives, raw materials and plant, and the steel industry and national objectives. The following article is an abridged version of the report.*

PRODUCTIVITY AND INCENTIVES

The last visit to Russia which examined the steel industries was the Trade Union Mission of 1945. They then reported that productivity was not high in Russia and that they had a considerable way to go before they caught up with the United Kingdom. The present visit ten years later suggests that at their more modern plants, at least, the output per man is very similar to comparable plants in this country.

Of the plants visited, the two integrated works, Zaporozhe in the Ukraine and Rustavi in Georgia, have a combined annual output of 2½ million tons with an employment of 21,500 persons. It is difficult to make exact comparisons between plants as the balance of output varies and plants are in different stages of development. But the output per man at plants at the top end of the British scale, covering about 25 per cent. of our output, would be broadly comparable to these Russian plants. The two Russian plants are also among their better works. But they are still developing and will improve further in the future—so too will the best British plants. A rapid rate of progress will be needed if output per man in the western countries is to keep pace with Russian progress. Indeed the view is expressed in Russia that they have caught up with Western Europe—but they still lag behind America, and have their sights set on narrowing this gap.

It is interesting, in passing, to compare the rate of expansion in the Russian steel industry from an output that will probably reach 45 million tons in 1955 and is expected to rise to 60 million tons in 1960, with the current British five-year expansion plan. The Russian production per head of the population is at present about half that of the United Kingdom, and if the Russian output objective is not revised—as may happen of course to plans both in Russia and in this country—the rate of expansion in both countries over the next few years, in terms of steel output per head of the population, should be almost identical. This would still leave the output per head in Britain about double that of Russia—which in view of the much higher proportion of workers in agriculture in Russia may not be itself surprising.

CONTINUOUS STRIP MILLS

Pig-iron output in both countries is expected to rise in the future more rapidly than steel output. In Russia the present objective is 50 million tons of pig iron in 1960. It seems likely that in Russia there would also require to be very heavy expenditure on rolling-mill developments, particularly in continuous strip mills, where in relation to the size of the industry they are at present behind in development, yet they have an objective in mind, not necessarily to be achieved by 1960, of 40 per cent. to 45 per cent. of the total steel output to be in flat products.

* Lecture in connection with the Autumn General Meeting of the Iron and Steel Institute delivered in London on Wednesday, November 16, 1955.

† Executive Member of the Iron and Steel Board and leader of a party of experts from the British steel industry who, together with representatives from Belgium, France and Sweden, recently visited Russia under the auspices of the Economic Commission for Europe.

The question of productivity merits further discussion. Apart from the design and operation of plant—and good examples could be seen—a main method used for obtaining high output per employee is an intensive use of financial incentives supplemented by propaganda and social rewards. Basic wage rates are determined on what is essentially a job-evaluation basis with an ascending scale of 12 basic rates of wages. To these basic rates bonuses are added when the output norm set for each section of the plant is exceeded. The norm is usually about 80 per cent. of the planned output of the plant and is commonly exceeded. The scale of additional payment for extra output is on an accelerating scale, so that if 10 per cent. extra output secures 20 per cent. extra income, 20 per cent extra output would secure 40 per cent. extra income. This gives earnings which range from about 600 roubles a month up to 2,000, or when account is taken of the specially high earnings of highly-productive iron-ore workers or first-hand melters, up to a maximum, including bonuses, of 3,000 to 4,000 roubles a month.

DISPARITY OF INCOME

The average wage in the steel industry is between 950 to 1,000 roubles a month. A works director can well earn 7,000 roubles a month, of which almost half would be bonus.

As income tax reaches its maximum rate of 13 per cent. at 1,000 roubles a month, the range of net earnings both as between classes of employees and as between employees and higher management would seem to be as great if not greater than in this country. In order to get the same disparity in net income in the United Kingdom as in Russia the earnings of higher management, after making allowance for progressive taxation and super tax, would require to be £12,000 a year in relation to an average wage in the steel industry of about £600 a year.

Financial incentives are also used to attract labour into the coal, steel and petroleum industries, where rates are higher than in other industries—and they are also 20 per cent. higher in Eastern than in Western Russia for a similar reason. It is the practice increasingly to build new steel plants away from industrial towns, and while the new works is being erected to build alongside it new communities. The attraction of the better housing than is available in the older cities or in the countryside is another factor enabling the steel industry to attract labour even though new works are frequently built in isolated districts—as for example the post-war plant at Rustavi, 20 miles outside Tbilisi in Georgia.

EMASCULATED UNIONS

Labour is not tied to a particular works, but employees lose their seniority bonus, of 10 per cent. on the wages after three years, if they move without agreement. Seniority secures a bonus, but promotion is on merit. Employees also lose their credits towards the pension which is available on reaching the age of 50, providing 20 years' service have been completed, if they leave without the agreement of the management. The industrial pension is an alternative to the state pension and is more favourable. In both cases the pension is paid whether the employee continues in his job or retires. Women are expected to take work outside the house; they do a wide range of tasks from rough manual work to overhead crane driving.

The trade unions play a less decisive part in collective bargaining. The logic of the socialist state and nationalisation seems to have been pushed to its conclusion: all the workers from the management downwards are employees of the State and rates of wages are finally determined by the State. The apportionment of wages is on the basis of the value of the work and the need to secure the maximum incentive to high output. The trade union function is mainly to supplement the productivity of the plant and in particular to give special attention to welfare services.

The use of financial incentives would be of little value if it were not supported by a concentration on technical and scientific education. Employees at all levels are encouraged to undertake technical training and the passing of operatives' examinations is an important factor in promotion within the works. Training at the lower levels has a particular importance when a high proportion of inexperienced labour has to be drawn into the industry.

In practice there are undoubtedly a wide range of operational difficulties in the system. There is internal discussion or as it is normally called "positive criticism" about how to give more responsibility to works directors; how to reward the man who finds ways of moving norms higher as distinct from the easier achievement of exceeding an established norm; the problems of the shortage of components, or wrong costing or bad planning. There is even a readiness to laugh at excessive meetings and conferences.

RAW MATERIALS AND PLANT

In terms of the level of wages the cost of coking coal delivered to the steel works would seem to be slightly higher than in the United Kingdom. Oil was expensive in relation to producer coal and at one of the plants a change was being made from the use of oil to coal producer gas, which is the reverse of the trend in this country. Coking coal is frequently high in ash and sulphur. There is public discussion on the need, as well as the possibility of the more rapid expansion of oil production and the development of natural gas. Coal output is expanding.

The main raw material advantage of the Russian steel industry is the abundance and relatively low cost of its iron ore—even though increasing attention is having to be paid to the use and preparation of lower-grade ores. At Krivoi Rog, the great iron-ore centre of the Ukraine, the 55 per cent. high-grade ore is declining and a proportion of the total output and the concentration and sintering of 36 per cent. ore is being developed extensively. This ore is opencast and after treatment to give a 60 per cent. sinter, is available at about a third of the present cost of the comparable ores imported into the United Kingdom. Scrap is price-controlled at a ratio to wages somewhat above that of the United Kingdom.

The Russian steel plant at the modern works visited follow with some improvements and some recognised deficiencies the general lines of corresponding works in the United Kingdom. It is clear that every effort is being made to increase further the efficiency of even these plants.

With a comparable level of efficiency to that of Western European countries and with a generally favourable raw-material supply, it is not surprising that in Russia the price of steel—about 600 roubles a ton for round bars—bears much the same relationship to wages as British steel bears to British wages

The broad similarities of cost relationship which we found between Britain and Russia seem to extend to wider aspects of the Russian economy than steel, though here we speak with more slender evidence. For example, the cost of building the Rustavi steel works in relation to steel prices, and equally to wages, was much the same as for a similar plant in the United Kingdom. Even the price of many metal consumer goods followed this general relationship. Motor-cars, television and radio sets, and gramophones are all priced in terms of wages at much the same level as in Britain.

NATIONAL OBJECTIVES

Where the Russian economy diverges from the British is in the substantially higher prices for non-mechanical consumer goods. Food,

in relation to wages, is about three times as high as in Britain, and clothes probably four times as high. That consumer goods on average are roughly twice as dear in relation to either wages or steel prices as in Britain, is one of the factors that makes the assessment of the exchange rate between the rouble and the pound sterling difficult.

The dilemma and its significance in relation to steel prices can be put in the following terms. If the rate of exchange is taken at the official rate of 11·2 roubles to the pound, wages, and steel prices in Russia would be nearly double those of the United Kingdom and exports of Russian steel or of most manufactured goods generally for that matter, would not be competitive unless they were dumped abroad at prices below the home-market level.

If at the other extreme, the exchange rate is taken at about 40 roubles to the pound, the cost of living in the two countries would be roughly equated, but wages and steel prices in Russia would be half those of Britain. On this basis Russian steel prices would be the lowest in the world.

If the exchange rate is taken at between these two limits, say, at 20 roubles to the pound, wages and steel prices would be about equal in Britain and in Russia. But the prices of consumer goods would average roughly double those of Britain.

CURRENT SACRIFICE FOR CAPITAL DEVELOPMENT

If trade could be imagined as flowing freely between the countries, I am inclined to think that the exchange rate would settle at much nearer 20 than 40 roubles to the pound—and on this basis steel and at least a number of manufactured goods from Russia would probably be as low and frequently below prices in the West. But the cost of living would be higher in Russia and the tourist would still find Russia a very expensive place to visit.

The reason for the relatively high cost of consumer goods in terms of wages can perhaps partly be found in lower efficiency but perhaps more significantly in the deliberate Government policy of taxing consumer goods by what is the equivalent of a turnover tax. This limits consumption and frees resources—in a way that must be the envy of Mr. Butler—to further the other objectives of the economy.

To sum up, the undoubtedly great industrial progress in Russia seems to stem from: (1) its favourable raw-material resources; (2) its labour resources and concentration on technical and scientific education; (3) the open and accepted use of every possible incentive, and in particular financial incentives, to higher productivity; and (4) the devotion of a large part of the country's resources to capital development at the sacrifice of present consumption.

A FORMIDABLE COMPETITOR

The problem in Russia is indeed essentially that of the Western countries, namely of balancing the consumption requirements of the population with the need to have adequate resources for capital development both within the country and overseas. The limitation of consumption is undoubtedly one of the major factors in enabling a rapid rate of industrial growth to be achieved. The concentration of resources on industrial development, at the expense of current consumption, is claimed openly in Russia to be a major advantage their economy has over those of the West.

So long too as the Russian worker accepts half the real standard of living of the British worker and achieves a somewhat comparable level of productivity, Russian industrial products can well be sold cheaply on world markets. If the future is to lead to greater freedom in trade between the East and West, there is every reason for a very real concern over the competitive power of Russia, and particularly its competitive power in the field of steel and products made from steel.

BEVEL GEAR CUTTING MACHINES

Half-yearly Meeting and Luncheon of the B.G.M.A.

Every six months the British Gear Manufacturers Association hold a general meeting, at which is usually presented a paper of broad interest concerning the design, production, testing or application of gears, followed by a luncheon. It cannot be certain whether the gear manufacturers are attracted to hear the paper by the prospect of a luncheon, or attend the luncheon merely to continue discussion of the paper, but whichever is the case these meetings are invariably well attended, and the institution is a good one—a well balanced combination of profit and pleasure. At the recent meeting on November 8, held as is customary in the Piccadilly Hotel, London, the technical paper was delivered by Mr. G. W. Nash, M.I.Prod.E., of Buck and Hickman Limited, who spoke on "Recent Developments in Bevel Gear Cutting Machinery—the Gleason Method."

Mr. Nash dealt with Gleason machines designed for the following purposes: for cutting and grinding straight and curved tooth bevel gears, Curvic couplings and face clutches; for sharpening and maintaining the cutters used; for hardening bevel gears, spur gears, shafts and other components; and for testing, burnishing and lapping gears. He also gave an historical account of the development of these machines and described the principles employed in their design and operation. He explained, for example, that the method of generation in all Gleason spiral and hypoid generators was basically the same, although the method of effecting the generation varied between machines. A rotating, circular face-mill cutter was commonly used on the spiral bevel gear generators to produce lengthwise curvature of the spiral bevel gear teeth, while the gear tooth profiles were generated by means of a relative rolling motion between the circular cutter and the gear being cut.

Among the numerous machines described was the new No. 104 straight bevel Coniflex generator, which combines universality with the high production rate of the Revacycle system. The Revacycle process is a method of completely generating straight bevel gear teeth in one cut from the solid metal. A large diameter, disc-type cutter is employed. The cutter blades extend radially outwards from the cutter head, and each blade has two concave cutting edges, which produce convex profiles on the gear teeth. Each blade is relief ground so that it cuts the same shape after sharpening, this being effected by grinding the front face only.

The No. 104 Coniflex generator is a completely automatic high-speed machine and accommodates gears up to 8½ in. in diameter, 1⅜ in. in face width and a diametral pitch of 3.

SIMPLICITY IN GEAR DESIGN

At the luncheon which followed the reading of the paper, Mr. J. E. Skidmore, chairman of the Association, presided. The response to the toast "The Guests," proposed by Mr. Skidmore, was made by Professor W. A. Tuplin, D.Sc., M.I.Mech.E., Professor of Applied Mechanics, University of Sheffield, who said that gears were a simple means of doing a difficult job. In fact they were being made simpler each year, but there was still scope for further simplification and standardisation. Some people thought that a new gear was good merely because it was different, others were not prepared to accept a standard because their machines were not capable of cutting in accordance with it; it was thus very difficult to establish standards in gear production. In addition, Professor Tuplin spoke scornfully of those engineers who, faced with a decision, asked what the Americans did. He also referred to the academic ability shown nowadays by women engineering students, and the problem of placing them when their studies were complete.

WORK OF BRITISH STANDARDS INSTITUTION

Future Standards for Atomic Energy

The annual report of the British Standards Institution for 1954-5 shows that in the field of engineering 102 new standards were published during the year, 113 standards were revised or amended, 137 draft standards circulated for comment and 127 items of new work started. A Council of Codes of Practice was constituted early in the year and four committees—for Buildings, Civil Engineering, Electrical Engineering and Mechanical Engineering—were set up. Codes of Practice had already been issued at the time of the report for site investigation, earth-retaining structures, foundations, drainage-sewage and installation and maintenance of underfeed boilers. Codes were in preparation on a number of other subjects including earth works, pavings, electrical installations, selection and installation of electric cooking equipment, street lighting, abatement of radio interference, gas cooking installations, installation of gas-heating appliances, central heating by low-pressure hot water, mechanical ventilation, domestic butane-gas burning installations and electric fire alarms.

The previous year saw the publication of a number of important standards which had been under preparation for some years. These were the revised standards for limits and fits and drawing practice and a new standard on preferred numbers. During the year under review this work entered a new phase with the discussion with the United States and Canada of B.S. 2517, "Definitions for Use in Mechanical Engineering." Although there are some different usages in the respective countries, B.S. 2517 may well prove to be one of the foundations of future "ABC" classification.

Work on co-ordination of existing standards is an important part of the Institution's activities. A major review was in progress of the many standards for steel products and a special committee has been set up to co-ordinate standards which are of common interest to the chemical engineering, mechanical engineering and petroleum equipment industries. A new field of work is indicated by the report of preliminary discussions with representatives of the Atomic Energy Authority on the standards which will be required in this industry as it is developed for peaceful purposes. The scale of activity of the Institution's international work is increasing rapidly, a very large programme of meetings of the technical committees of the International Organisation for Standardisation being the main cause of this increase.

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CONCRETE QUALITY CONTROL

Technique of Accelerated Hardening

Last week, on page 684, we briefly reported a technique for the accelerated testing of concrete cubes, developed by Professor J. W. H. King of Queen Mary College, London, whereby the 28 day strength of concrete could be predicted from tests made only seven hours after mixing. In our summary, the technique was said to involve "drying" the test cubes under standardised temperatures slightly below that of boiling point. Professor King has asked us to point out that, in the technique which he is advocating, every precaution is taken to ensure that no water is lost from the concrete and that the cubes are kept hot and moist so that the hardening rate is accelerated.

WHAT ARE A POUND AND A YARD?

IMPERIAL STANDARDS IN QUESTION AFTER 100 YEARS

By L. C. Porter, D.P.A., F.I.W.M.A.*

The Imperial Standard Yard and the Imperial Standard Pound are the fundamental units of the British system of weights and measures and from them not only have all other United Kingdom denominations of weight and measure been derived but also most of the primary standards of the Commonwealth countries. Just one hundred years ago they were legalised by the Standards Act, 1855.

The previous Standards, a Yard and a Pound (Troy) of 5,760 grains, said (erroneously, perhaps) to have been immured in the walls of the Palace of Westminster, were damaged by the fire which destroyed the Palace in 1834. To re-establish the primary standards of weight and measure from the other standards then existing, a Commission was appointed. Scientific investigation and research of a far-reaching and minute character followed and the two new standards were legalised in 1855 but, instead of the Troy pound of 5,760 grains, the Avoirdupois pound of 7,000 grains was constituted the "Imperial" measure of weight.

THE STANDARDS

The Imperial Standard Yard is a bronze bar, one square inch in section, declared to be the "imperial standard for determining the imperial standard yard, measured when the bar is at the temperature of 62 deg. Fahrenheit, and when it is supported on bronze rollers placed under it in such manner as best to avoid flexure of the bar, and to facilitate its free expansion and contraction from variations in temperature." The bar is 38 in. in length and near each end a cylindrical hole has been sunk to the depth of half an inch. At the bottom of each hole has been inserted, in a smaller hole, a gold plug about 1/10th in. in diameter upon which have been cut three fine lines approximately 1/100th in. apart transverse to the axis of the bar and two lines at about 0·03 in. apart and parallel to the axis of the bar. The length of the Imperial Yard is the distance between the middle transverse line at one end and the middle transverse line at the other, measured from a midway point between the two longitudinal lines.

The Imperial Standard Pound is of platinum, the form being that of a cylinder nearly 1·35 inches in height and 1·15 inches in diameter, with a groove or channel round it, whose middle is about 0·34 inches below the top of the cylinder for the insertion of the points of the ivory fork by which it is lifted; the edges are carefully rounded off, and such standard pound is marked P.S. 1844, 1 lb.

In view of the difficulties created by the loss of the old standards, it was only natural that serious consideration was given not only to the construction of new standards but also to their future safe keeping. To neutralise flexure during storage, the Yard is supported on eight rollers. Covers protect the defining lines and when the Yard is placed in its box provision is made to prevent lateral movement. The Pound, wrapped in prepared Swedish tissue paper, is first placed in a silver-gilt box and then into a bronze case which is screwed down. The Pound is then placed in the same box as the Yard and kept in a specially constructed dustproof and fireproof safe in the strong room of the Standards Department, Board of Trade.

PARLIAMENTARY COPIES AND ACCURACY

To avoid a similar loss of the Imperial Standards the Commission recommended that four copies of each of the standards should be made and should be known as the Parliamentary Copies. One each of the copies are deposited at the Royal Mint, the Royal Society of London, the Royal Observatory of Greenwich, and the New Palace of Westminster (the Houses of Parliament—being immured in the walls). A fifth set, legalised in 1886, is deposited at the Standards Department.

Section 35 of the Weights and Measures Act, 1878, provides that the Board of Trade shall cause the Parliamentary Copies, with the exception of those immured in the walls of the New Palace of Westminster, to be compared once every ten years with each other and once every 20 years with the Imperial Standards. Despite the exception the immured copies were examined in 1892 and 1922, being found intact and uninjured, and were taken into comparison with the other copies and the Imperial Standards.

The Report by the Board of Trade on the Comparisons of the Parliamentary Copies of the Imperial Standards (Cmd. 3507, 1930) also gives a full description of the disinterment and replacement of the immured standards in the presence of the Speaker of the House and other officials. At the replacement, after being packed in a manner similar to that described earlier for the Imperial Standards, the mahogany case containing the copies of the standards was placed in an oak box with a lead lining. The lead lining was soldered and the outer lid of the oak box screwed down, after which it was placed in "the recess of the stone wall under the blank window on the right-hand side of the second landing on the public staircase leading from the lower Waiting Hall up to the Commons Committee Rooms in the Palace of Westminster." The stone forming the front of the recess was then placed in position and cemented in.

As stated earlier, comparisons between the Parliamentary Copies and the Imperial Standards should be made every 20 years. Reports on the comparisons made in 1922 (they took five years from 1922-27), 1932 (1932-33) and in 1947 (1947-48) were issued in 1930, 1936 and in 1950 respectively by the Board of Trade. The procedure adopted for the comparisons and the results are set out in great detail. Evidence as to the results obtained was given to the Hodgson Committee of Inquiry into Weights and Measures Legislation and is set out in the report issued by them in 1951 (Cmd. 8219). What follows is taken from information given in that report.*

Commenting on the workmanship and material of the Imperial Standard Yard the Committee report that it compares unfavourably with that of the International Prototype Metre and the British and other copies of the Metre. Nine comparisons have been made since the original verification in 1846, the latest being in 1947. The conclusion reached is that since 1900 the Yard has shortened by nearly two parts in a million and that the four original copies have also shortened by the same amount. The later copy, legalised in 1886, has shown a rate of shortening approximately double the amount of the original copies, indicating their probable rate of shortening in the earlier period of their existence.

The defining lines on the Yard and the Parliamentary Copies are inferior to those of the International Prototype Metre and its national copies in that the accuracy of comparison obtainable with the Imperial Standards may be assessed at about 0·000 02 in. as against that of the Metric Standards of 0·000 004 in. Criticism is also made of the use of the Fahrenheit thermometer for which there is no known legal definition.

Comparing the results obtained in the comparisons of the Imperial Pound, on ten occasions including the initial comparison in 1846, the conclusion is reached that the pound has diminished progressively by 50 parts in 100 million between 1846 and 1883 and by a further 19 parts in 100 million between 1883 and 1933, but has not changed appreciably since.

COMPARISONS WITH THE METRIC AND AMERICAN SYSTEMS

Comparisons between the Yard and the Metre reveal that variations have occurred which give rise to serious practical difficulties in prescribing the value of the one in terms of the other. For instance the 1878 Act gives a table of equivalents which may be lawfully used for computing and expressing metric weights and measures, in which 39·370 8 in. were said to equal one metre. In 1895 the ratio was found to be 39·370 113 in. to the metre; in 1927, 39·370 147; and on the latest determination 39·370 186 in. The 1878 equivalent for the inch, 25·399 54 mm., was not 1/36th of the metric equivalent of the yard nor in line with the converse metre/inch ratio quoted above. In 1898 an Order in Council gave a new table in which the inch was given the value of 25·400 mm. But this value, which may be convenient for trade purposes, does not agree with the more accurate value given in the same Order for the ratio of the yard to the metre. More recently the value of the inch has been shown to be about 25·399 93 mm. Furthermore the United States of America equivalent, fixed in 1866 as 39·37 in. to the metre, is now 25·400 05 mm., as against the present actual value of the British inch, 25·399 93 mm., and the legal value of 25·400 mm. Such extremely small discrepancies in value may appear insignificant, but they are of importance by scientific criterion and to-day have certain aspects of international importance. With the increased accuracy in the manufacture of standard reference gauges, used in precision tool and inspection rooms, where values standardised to one part in a million are sometimes called for, gauges made in the U.S.A. would not be the same as those made in Great Britain and to this extent it can be said that the two countries have different standards of length.

While the difference between the U.S. Pound (0·453 592 427 7 kg.) and the British Pound (recent experimental value, 0·453 592 338 kg.) could create a similar position, it has not, as yet, affected trade in any way.

In their recommendations the Committee included the defining of the Imperial Yard as 0·914 4 of the International Metre and the Pound as either 0·453 592 37 or 0·453 592 3 of the International Kilogramme. They also recommended that the United States Government should be approached with the hope of securing identical values for the yard and the pound in both countries. There is reason to believe that some consultations have taken place, but no information is available as to the progress made.

As a footnote it is interesting to record that the average degree of accuracy in the local standards, which have been derived from the Imperial Standards and are possessed by local authorities, is one part in 9,300. Even weights, measures and weighing and measuring appliances in use for trade in this country have an average accuracy which is very high; in some cases involving an error of only one part in 4,400.

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TITANIUM FABRICATION

I.C.I. Factory in South Wales

Imperial Chemical Industries Limited, have announced that they are to build a factory for the fabrication of titanium near their existing works at Waunarlwydd, Swansea. Work is to begin as soon as possible and it is hoped that the new factory, which will cost about £2 million and employ some 250 persons, will be in production in 1958. Some fabrication into wrought forms, is at present being carried out at the Kynoch Works of the firm's Metals Division in Birmingham, and in other Metals Division factories, but the demand for aircraft and other industries is developing so rapidly that the company have decided to build the new factory.

* Chief Corresponding Member, The Institute of Weights and Measures Administration.

* *Editor's Note:* See also ENGINEERING, "Weights and Measures", leading article on the Hodgson Report, page 598, vol. 171 (1951); and H. S. Rowell, "Freedom to Measure: Yards or Metres?", ENGINEERING, page 744, vol. 171 (1951).

PERSONAL

Two Royal Medals for 1955 have been awarded by the Council of the Royal Society, Burlington House, London, W.1. One is to SIR ALEXANDER TODD, F.R.S., Professor of Chemistry, University of Cambridge, for his work in organic chemistry and the other to Professor V. B. WIGGLESWORTH, C.B., F.R.S., Quick Professor of Biology, University of Cambridge, for his work on insect physiology.

MR. J. A. R. KAY, F.R.Ae.S., director of A. V. Roe & Co., Ltd., Manchester, and executive assistant to SIR ROY DOBSON, the managing director, has been appointed general manager of the company.

MR. G. BUCHANAN, B.Sc., principal surveyor to Lloyd's Register of Shipping, at Sunderland, is to be transferred to the Society's head office for responsible duties on the chief ship surveyor's staff. MR. H. L. WALKER has been appointed principal surveyor at Sunderland in succession to Mr. Buchanan.

MR. W. FILLINGHAM BROWN, B.Sc., M.I.C.E., F.I.P.H.E., late chief engineer, Colne Valley Sewerage Board, is now practising as a consulting engineer at Dacre House, Victoria-street, London, S.W.1. (Telephone: ABBey 4017 and 4835). He will deal with all matters concerning public-health engineering including water supply, drainage, sewerage, sewage and industrial-wastes treatment, and river pollution.

The President of the Board of Trade has appointed MR. C. H. G. MILLIS, D.S.O., O.B.E., M.C., to be a part-time member of the National Research Development Corporation for a period of three years, in succession to SIR EDWARD DE STEIN, who has resigned in view of his business commitments. The National Research Development Corporation was set up in June, 1949, under the Development of Inventions Act, 1948, for the purpose of developing and exploiting inventions resulting from publicly financed research, and other inventions which appear to be worthwhile but are not otherwise being brought into use.

MR. H. T. HORSMAN has been elected chairman and MR. J. R. ROBERTSON honorary secretary of the new Western Centre of the Institution of British Agricultural Engineers. This will cover the Counties of Monmouthshire, Gloucestershire, Herefordshire, Wiltshire, Somersetshire and Dorsetshire—east of Bridgwater to Dorchester. Its meeting places are to be at Bristol and Chippenham.

MR. H. A. A. WHILE, London office manager of the United Steel Companies Ltd., Sheffield, has been appointed a director of the Workington Iron and Steel Co. Ltd.

The British Transport Commission announce that MR. L. P. WALL has been promoted to the position of district engineer (Midland), South Western division, British Transport Waterways.

Shell-Mex and B.P. Ltd., Shell-Mex House, Strand, London, W.C.2, have announced that MR. G. A. BAXTER is to be group manager responsible for the northern group of divisions and that MR. C. A. R. MOTT is to be manager of the kerosine and agricultural department.

MR. M. H. RUTLEDGE has resigned his post with the filtration division, Newall Group Sales, Ltd., to take up the appointment of sales manager, "Filtrall" division of C. A. Swales (Filters) Ltd.

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COMMERCIAL

THE INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS have moved into new and larger office premises at 6 Buckingham-gate, London, S.W.1. (Telephone: TATe Gallery 8589.) It is intended that the 1956-57 and all future sessions of the London open meetings of the Institution should be held at this address.

SHAW PROCESSES LTD., 25 Clyde-vale, Dartmouth-road, Forest Hill, London, S.E.23, and 41 Carliol-street, Newcastle-upon-Tyne, have concluded arrangements with the METROPOLITAN-VICKERS ELECTRICAL CO. LTD., Trafford Park, Manchester, 17, whereby Shaw Processes now have the exclusive right to arrange sub-licence agreements relative to the "Investment X" process of precision casting. Shaw Processes Ltd. have also concluded an agreement with BRITISH INDUSTRIES CORP., New York, for the establishment of a company, SHAW PROCESSES DEVELOPMENT CORPORATION INC., Long Island, to exploit the Shaw process of precision casting by the granting of licences throughout the United States and Canada.

The final stage in the transfer of the A.P.V. Co. LTD., to their new works at Crawley, Sussex, will be completed towards the end of December when the administrative, sales, technical and drawing office staff move into a new block of offices. The laboratories moved during November. From December 24 all communications should be addressed to the A.P.V. Co. Ltd., Manor Royal, Crawley, Sussex (Telephone: Crawley 1360), except those for the chemical engineering department which will be accommodated, together with the company's London office, at an address to be announced later.

The head office of CABLE AND WIRELESS LTD. has been moved from Electra House, Victoria-embankment, London, W.C.2, to Mercury House, a new building at 110-124 Theobalds-road, London, W.C.1. (Telephone: CHAncery 4433). The move began on November 14 and was due to be completed on November 24.

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CONTRACTS

Dam on the Indus. A British company, GAMMON (PAKISTAN), LTD., Karachi, have been awarded a contract valued at upwards of £4¾ million for the erection of a dam 4,600 ft. in length on the River Indus at Gudu. The dam, which will be situated some 400 miles north-east of Karachi, will not only protect from floods cultivated areas in Upper Sind and Baluchistan but will bring an additional 2,300,000 acres of land under cultivation.

Colliery Winding Machine. An order, valued at £93,000 for a fully-automatic Ward Leonard control, four-rope friction winding machine to be installed at Seafield Colliery, East Fife Area, National Coal Board, has been entrusted to the GENERAL ELECTRIC CO. LTD., Magnet House, Kingsway, London, W.C.2. The machine will serve the No. 1 shaft at this colliery and is designed to raise a load of coal of 15 tons per wind, in skips, from a depth of 1,930 ft. This will give an output of 615 tons of run-of-mine coal per hour. The 10 ft. diameter friction drum will have a speed of 59·45 r.p.m., and carry four 1¼ in. diameter locked coil ropes. Twin direct-current motors of 1,350 h.p., to be built at the company's Witton Works, will drive the drum through single reduction gearing.

Motorships. Two orders for motorships have been placed with BARTRAM AND SONS LTD., South Dock, Sunderland. The first is for a single-screw vessel of 10,000 tons deadweight capacity for the North Shipping Co. Ltd. (managers, Hugh Roberts & Son), Newcastle-upon-Tyne. The principal dimensions are: length between perpendiculars 425 ft., breadth extreme 58 ft. 9 in., depth moulded to main deck 30 ft., and draught 26 ft. 1 in. The propelling machinery will consist of a NORTH EASTERN MARINE-DOXFORD four-cylinder engine developing 4,400 b.h.p. to give a service speed of 13¼ knots.

The second vessel is for the Court Line Ltd., London (managers, Haldin & Co. Ltd.) and will be a repeat of the M.S. Hannington Court. She will have a deadweight capacity of 10,880 tons on a draught of 26 ft. 11 in., and her length, between perpendiculars, will be 445 ft., her breadth extreme 62 ft., and her depth to the shelter deck 40 ft. 2 in. The propelling machinery will be of the KINCAID-B. & W. type giving the ship a service speed of 12½ knots.

Power Station and Transmission Line Equipment. Contracts were placed by the Central Electricity Authority during October for power station, transforming station and transmission line equipment amounting, in the aggregate, to £3,374,917. The principal contracts include: For Tilbury power station: high-pressure pipework and valves, with JOHN THOMPSON WATER TUBE BOILERS LTD. For Willington "A" power station, near Derby: auxiliary service pumps, with GWYNNES PUMPS, LTD., and 132 kV and multicore cables, with PIRELLI-GENERAL CABLE WORKS, LTD. For Rogerstone power station, Monmouthshire: sidings accommodation, with the BRITISH TRANSPORT COMMISSION, WESTERN REGION. For Ealing, London: two 40 MVA 66/22 kV transformers, with FULLER ELECTRICAL AND MANUFACTURING CO. LTD. For Fleet, Hampshire: a 120 MVA 275/132 kV transformer with HACKBRIDGE & HEWITTIC ELECTRIC CO., LTD. For Coventry South substation: Two 60 MVA 132/33 transformers, also with HACKBRIDGE & HEWITTIC ELECTRIC CO. LTD. For Castle Donington, near Derby: 275 kV switchgear, with the BRITISH THOMSON-HOUSTON CO. LTD. For Bangor: a 45 MVA 132/33 kV transformer, with HACKBRIDGE & HEWITTIC ELECTRIC CO. LTD.

Contracts for 132 kV overhead lines include one from Bridgwater to Taunton, with RILEY AND NEATE LTD., and others from Carmarthen Bay to Trostree Tee Point, with PIRELLI-GENERAL CABLE WORKS LTD.; from Rochdale to Nelson, with BRITISH INSULATED CALLENDER'S CABLES; LTD.; and from STELLA SOUTH TO HERRINGTON BURN, with RILEY AND NEATE LTD. Other contracts are for modifications to the 132 kV overhead line from Littlebrook to Hastings, with W. T. HENLEY'S TELEGRAPH WORKS CO. LTD., and a 275 kV overhead line from Iver to West Weybridge, with BALFOUR, BEATTY & CO. LTD.

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Obituary

COLONEL N. T. BELAIEW, C.B.

A Metallurgist of International Renown

The death of Colonel Nicholas Timothy Belaiew, which occurred in Paris on November 6, was announced during the autumn annual meeting of the Iron and Steel Institute, held in London on November 16 and 17. Colonel Belaiew, who was 77 years of age, was a Russian metallurgist well known for his researches on the crystallisation of metals and in particular steel, and also for his painstaking work in metallography. His three main branches of research comprised the study of the manufacture and uses of Damascene steel; the investigation of the primary and secondary crystallisation in steel and the origin of the Widmanstätten structure in steels and in meteorites; and the study of the constitution and solid geometry of pearlite, sorbite and troostite in steels.

Destined for the army, he entered the Michael Artillery Academy in St. Petersburgh, where he studied metallurgy under the late Professor D. K. Tschernoff. When the war of 1914-1918 broke out he saw active service on the Russian front, but in the early summer of 1915 was recalled from his unit and came to England as a member of a mission headed by General Hermonius to help in the production of war material and munitions. He remained in this country after the Russian Revolution and carried out research work and also undertook consulting work in various branches of metallurgy.

In 1931 he went to live in Paris, where the remainder of his life was spent and where, for some years, he made a study of the structure of welds and weld metals in conjunction with researches initiated by the Institut de la Soudure Autogène.

Colonel Belaiew was elected a member of the Iron and Steel Institute and of the Institute of Metals in 1912 and, in 1938, was awarded the Bessemer Medal of the former body.

For his services to the Allies in the war of 1914-1918 he was created a C.B. by the British Government.

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MR. E. H. FORD, O.B.E.

Former City Engineer of Coventry

Mr. E. H. Ford, city engineer of Coventry from 1924 to 1949, died at his home there on November 14 at the age of 71. He was made an O.B.E. for his services in providing air-raid shelters in the city during the 1939-45 war. In 1950 he was appointed chairman of the Coventry Cathedral Reconstruction Committee. During the time he held office the committee negotiated for the acquisition of land for the cathedral, appointed assessors to consider the designs which were submitted in a competition arranged by the committee, compiled the Parliamentary Bill and finally appointed the contractors for the building of this modern and controversial design.

Ernest Hone Ford was born in 1884 in Bloxwich, near Walsall, Staffordshire, and received his education locally and at the Birmingham Technical College. He was articled in 1902 to the late Mr. R. H. Middleton, A.M.I.C.E., borough surveyor of Walsall, and later served with that corporation as an assistant until 1912, when he transferred to a similar post at Southport. In both these appointments Mr. Ford

saw the establishment and extension of main sewage disposal works and surface-water drainage systems.

In 1924 he was appointed City Engineer and Surveyor at Coventry and was again fortunate in finding himself involved in a period of great municipal activity with the construction of large works, particularly extensions to the main outfall sewers at a cost of about £750,000, and also extensions to the existing sewage disposal works and construction of a new works at a combined cost also of £750,000. In the years 1937 to 1939, Mr. Ford was concerned with the construction of the by-pass road for heavy traffic between London and the North West; it comprised dual carriageways as well as service roads and was 150 ft. wide and 7 miles long. An extensive programme of bridge reconstruction was commenced and some bridges completed, and main roads through the city were widened, but the war intervened to bring a projected five-year road programme to an end. Throughout the war he was responsible for engineering services connected with civil defence in the city.

Mr. Ford had been a Member of the Institution of Civil Engineers since 1931, having previously been an associate member since 1911; he served as chairman of the Midlands Branch in 1937–38. He was also for some years a member of the council of the then Royal Sanitary Institute and of the Institution of Municipal and County Engineers, of which he achieved the honour of being President in the year 1946–47.

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MR. N. C. BRIDGE

Mr. N. C. Bridge who died at Bridge of Weir on November 7, at the age of 72, was senior partner of Messrs. Strain and Robertson, the Glasgow consulting engineers.

Norman Cressy Bridge was born in London on September 2, 1883, and was educated at Streatham Grammar School, Cranleigh and Finsbury Technical College, where he obtained the diploma in 1901. He served his apprenticeship with the Newcastle-upon-Tyne Electric Supply Company at the Neptune Bank power station and then joined the North Eastern Railway at a time when the lines to the coast from Newcastle were being converted to electric traction. For a short time he acted as assistant constructional engineer to the Yorkshire Power Company, but in 1907 he joined the staff of Messrs. Strain and Robertson, consulting engineers, Glasgow. He became a partner in 1916 and was senior partner at the time of his death.

During his long association with the firm he had been responsible for the design of the Yoker and Clyde's Mill power stations of the former Clyde Valley Electric Power Company and of other similar works in Scotland. He was elected a Member of the Institution of Mechanical Engineers in 1931. He became an Associate Member of the Institution of Electrical Engineers in 1909 and was transferred to the class of Members in 1917. He was a past-chairman of the local centre of the latter body.

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We regret also to record the deaths of:

MR. ROBERT ABSALOM THOM, O.B.E., M.I.Mech.E., M.I.Loco.E., M.Inst.T., at his home in Ilkley, Yorkshire, on November 2, at the age of 82. A locomotive engineer, Mr. Thom was born and educated at Aberdeen and served his apprenticeship, from November, 1888 to November 1893, at the Kittybrewster Works, Aberdeen, of the Great North of Scotland Railway. He was eventually mechanical engineer of the L.N.E.R. for Scotland, at Cowlairs, Glasgow, and was then mechanical engineer, Southern Area, L.N.E.R. Doncaster, until he retired some 16 years ago.

MR. EDWARD MACLAREN HOOD, in hospital in Surrey, on November 17, at the age of 67. He was for many years Scottish Area officer to the British Electrical Development Association and had his headquarters in Glasgow. Owing to ill-health, Mr. Hood relinquished his position soon after the end of the war.

Book Reviews

FAR AS HUMAN EYE CAN SEE

The Foreseeable Future. By SIR GEORGE THOMSON, F.R.S. *Cambridge University Press, Bentley House, 200 Euston-road, London, N.W.1.* (10*s.* 6*d.*)

In these days of science fiction, even in comic strips, it is a healthy corrective to read what a distinguished scientist thinks of the distant future.

In this penetrating book Sir George Thomson describes only those likely developments which do not contradict known principles and which have an obvious utility, although he admits that there will probably be discoveries which transcend what now appear as major impossibilities. He believes that it is reasonable to try to predict the trend of future discoveries because, unlike many developments in the past, they are likely to be based on scientific principles rather than mechanical ingenuity, and these principles, of which he names seven, set limits to what can be done in the future.

It is not surprising that in his own field of physics his ideas of what may be practicable in the future are given the most extensive scientific support; and it is therefore the more interesting that they should appear far more revolutionary than elsewhere. After reading his fascinating description of possible methods of space travel, with rockets jet propelled by fission particles cruising about the solar system, it is rather an anti-climax to learn that the motor car will remain the fastest method of door to door transport and has probably reached its optimum speed, and that for air flights of less than 1,000 miles a subsonic jet will do all that one wants. These ideas occur in a chapter on transport and communications which includes a real attempt to make the mysteries of modern information theory intelligible to the non-mathematical reader. The attempt to do this is hampered by the limitations imposed by a very short book, but it whets the appetite for a more extended explanation for the general public of some contemporary scientific theories.

Sir George is not in the modern fashion of scientific pessimism, but maintains a positive outlook on human progress. He does not see the growth of population and industrialisation as outstripping man's ingenuity in producing more food and raw materials, although the methods by which he will do so will be very different from those in use to-day. For example, the sea as a source both of metals and of fresh water for irrigation has real possibilities, and with the increasing use of synthesised feeding stuffs for cattle the need for cultivation of the soil will diminish and it might be possible to allow land to return to parkland. He envisages large herds of cattle, fed mostly on synthetic foods delivered automatically at distributing centres, being hunted with bows and arrows by chemical engineers in search of adventure. This passage illustrates a certain wistfulness in his attitude as he peers into a future in which monkeys are domesticated for work in factories, life is prolonged indefinitely, and those too stupid to do creative work as engineers, artists, teachers, scientists, administrators or salesmen are used to humanise a civilisation grown too mechanical, in jobs where kindness and patience are worth more than brains.

Finally, he issues a warning that those who are concerned with "values" in our society should be prepared for discoveries about the mechanics of the brain which might make difficult the retention of principles to which men have, in the past, attached great importance. On the other hand, the true fundamental relation of mind to matter is the deepest secret of the universe and may remain for ever an example of the significant but never known. From the utilitarian point of view, and judging by the size of the brain, man is very far from using his full mental potentialities. The limits to what he may reach as his brain improves are not foreseeable.

Dynamics of Machinery. By A. R. HOLOWENKO. *John Wiley and Sons, Incorporated, 440 Fourth-avenue, New York 16, N.Y., U.S.A.* (7.50 dols.); and *Chapman and Hall, Limited, 37 Essex-street, London, W.C.2.* (60*s.*)

This book covers part of the field which is normally called "Mechanics of Machines" in this country. Since there is at present no single book on mechanics of machines which can be recommended without reserve to a student, it is useful to know what the subject covers.

The difficulty about mechanics of machines as usually introduced in this country is that it commences with a nod to kinematics followed by a bow to what the present author calls the dynamics of machinery, and then proceeds to a quick handshake with half a dozen topics falling into the field called the "elements of machines" by the Continental writers. No unifying thread runs through the subject, largely because authors appear to have little acquaintance with the real problems of design of fast-moving machinery.

The present book has avoided these troubles by concentrating firmly from beginning to end on the problems involved in finding the forces on, and the stresses in, the parts of machines when they are moving, and thus is provided with a single theme. The author sums up his attitude to velocity and acceleration diagrams (and to all other incidental analytical tools) when he says (page 3): "Since dynamic forces are a function of accelerations, and since accelerations are a function of velocities, it is advisable to present a brief discussion on the fundamental concepts and definitions of velocities and accelerations." He then proceeds to take the discussion to the stage where auxiliary points are introduced to solve the problem of drawing velocity and acceleration diagrams for mechanisms for which the normal simple methods break down. Here, as elsewhere in the book, his step-by-step diagrams should make the methods clear to the least intelligent student, even if his verbosity may deter the better one. Unfortunately, he makes a mountain out of the molehill presented by Ccrioli's accelerations, but then proceeds to put cams in their proper perspective by treating them as equivalent mechanisms.

The treatment of static forces in machines is clear but might have been made much better by the introduction of the method of virtual work. His treatment of inertia forces and bending moments in machine components is excellent, although curiously split up into two widely separated sections in different parts of the book. The chapter on the fundamentals of balancing, with use of moment polygons, is admirable, whereas that on balancing machines is trivial, and the two chapters on the balancing of reciprocating masses are not merely too detailed, thus obscuring the principles, but lack the simplicity of treatment which vectorial representation might have given.

A chapter on vibration of shafts introduces Holzer's method, and ingeniously discusses the whirling of shafts with bearing friction, but makes no attempt to deal seriously with the fundamentals of forced vibrations; this is indeed putting the cart before the horse, and it may be hoped that in a future edition the author may condense his treatment of balancing to make room for proper treatment (preferably vectorial) of forced vibrations in machines. A final chapter on the gyroscope is confused by the author's difficulties with Corioli's accelerations.

In the field that it covers, this must at present rank as the best book; but at 60*s.* there should be two or three copies in the library rather than one on each student's desk. Its length (and price) could easily be reduced to the reader's gain.

BOOKS RECEIVED

Some of the books noticed here are selected for extended review in ENGINEERING.

The Surface Water Year-Book of Great Britain, 1945–53. Ministry of Housing and Local Government, Scottish Office. *H.M. Stationery Office, Kingsway, London, W.C.2.* (35*s.*)

This report is the complete statistics for rainfall and river discharge in England, Scotland and Wales for the period 1945–53. For reference purposes these areas are divided into 103 regions. For each region the following figures are given for every month during the period concerned: river discharge, run-off rainfall, peak discharge (and date of occurrence), maximum and minimum daily discharges. The critical figures are summarised in notes compiled for each region. As such the figures are of inestimable value to geographers and hydrological scientists; to engineers responsible for water supply, land drainage and hydro-electric schemes; and to those who employ river water for any industrial purposes.

Practical Design of Simple Steel Structures. Vol. I: Shop Practice, Riveted Connections and Beams, etc. By DAVID S. STEWART. Fourth edition. *Constable and Company, Limited, 10 Orange-street, London, W.C.2.* (18*s.*)

This, the first volume of a well-known text-book for civil engineers, structural and municipal engineers and students at universities and colleges, deals with shop practice in respect of structural steelwork. (It also contains the tables that were originally issued as Volume III.) Calculations are given for a number of frequently-occurring design problems, the mathematics being restricted to elementary standards. Fabrication by welding is not mentioned, the text relating solely to riveting practice. Introductory chapters also describe briefly the production of the steel sections and the work in the template loft, etc.

Richard Sutcliffe: The Pioneer of Underground Belt Conveying. By R. J. SUTCLIFFE and EDWARD D. SUTCLIFFE. Third edition. Privately printed for *Richard Sutcliffe, Limited, Horbury, Wakefield.* (Gratis; restricted distribution.)

The object of this book is to secure to the late Mr. Richard Sutcliffe such permanent place as may be his due in an appraisement of those who took part in the introduction and improvement of appliances for the benefit of the coal industry. It also aims to show the evolution of the belt conveyor as manufactured at the works founded by him, during his lifetime and afterwards. Since the publication of the second edition, changes have taken place within the company and in the products, and a section, written by the technical director and entitled "Present-day Products," has therefore been added in this third edition.

Outline of Work Study. Part II: Method Study. Production Management Series 2B. *British Institute of Management, 8 Hill-street, London, W.1.* (7*s.* 6*d.*)

After an introductory chapter, the book discusses selecting and recording the work for method study, outline process charts, flow process charts, two-handed process charts, multiple-activity time charts and simo charts, diagrams and models; examining the recorded facts; developing the new method—contingent consideration and the improved method; submitting the proposals to higher management; installing and maintaining the new method. Appendices are included on the string diagram, photographic aids, principles of motion economy, and bibliography.

Theoretical Hydrodynamics. By L. M. MILNE-THOMSON. Third edition. *Macmillan and Company, Limited, St. Martin's-street, London, W.C.2.* (60*s.*)

The presentation of the subject is consistently based on vector methods and notation, and demands no previous mathematical knowledge beyond the elements of the infinitesimal calculus. After an introduction to Bernouilli's theorem, properties of vectors essential to the analysis of fluid motion are discussed, followed by the general properties of fluid motion continuity, dynamical equations, pressure energy, and vorticity. Then follow chapters on two-dimensional motion, streaming motions, aerofoils, sources and sinks, moving cylinders, the mapping theorem of Schwarz and Christoffel, jets, currents and the cavity behind a cylinder in a stream, rectilinear vortices and Kármán vortex sheet, two-dimensional wave flow, Stokes' stream function and the application of conformal mapping to three-dimensional problems with axial symmetry, the general motion of spheres and ellipsoids, solid moving through a liquid, vortex motion in general with particular application to an aerofoil of finite span, viscosity and boundary-layer theory, and an introduction to the theory of flow of a compressible fluid at subsonic and supersonic speeds.

Techniques for Ruling and Etching Precise Scales in Glass and their Reproduction by Photoetching with a New Light-Sensitive Resist. By RAYMOND DAVIS and CHESTER I. POPE. National Bureau of Standards Circular 565. *The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A.* (30 cents.)

This publication describes two methods of making precisely graduated circles for theodolites. In one method, the glass circle is coated with a wax resist in which the graduation numbers are cut by a ruling engine, the glass then being etched. In the other method, the glass is coated with a light-sensitive resist, exposed in contact with a glass master negative, and then etched. The requirements of the precision circles and the method of engraving the resist are discussed. The development of resist coatings, their application to the glass and the methods of glass etching are also reviewed. In connection with the work a new mild etching solution containing phosphoric acid and hydrofluoric acid was developed. For use as a light-sensitive resist coating a phenol-formaldehyde resin was synthesised and the procedures for producing and employing this are explained in detail.

Turboblowers: Theory, Design, and Application of Centrifugal and Axial Flow Compressors and Fans. By A. J. STEPANOFF. *John Wiley and Sons, Incorporated, 440 Fourth-avenue, New York 16, N.Y., U.S.A.* (8 dols.); and *Chapman and Hall, Limited, 37 Essex-street, London, W.C.2.* (64*s.*)

This book deals with the hydrodynamic and thermodynamic design of turbocompressors, and covers the theory of the centrifugal impeller for incompressible fluid; the vortex theory of Euler's head for incompressible fluid; the general characteristics of turbo machinery; the hydraulic performance of centrifugal blowers; thermodynamics of turboblowers; special thermodynamic and hydrodynamic problems; blower casings; leakage, disc friction, mechanical lines and axial thrust; compression with cooling; centrifugal forces; single-stage axial flow fans and blowers; high-pressure multi-stage axial compressors; special problems and applications of blowers and compressors; and the design of mixed flow impellers. The theoretical treatment of the axial flow impeller is based on the actual "fluid deflection angles" rather than aerofoil lift coefficient.

A Study of the Double Modulated F.M. Radar. By MOHAMED ABD-EL WAHAB ISMAIL. *Verlag Leeman, Zürich, Switzerland.* (10.40 Swiss francs.)

Report No. 21 of the Institut für Hochfrequenztechnik of the Zürich Technischen-Hochschule describes the principles of, and experiments on, a double-modulated frequency-modulated radar; this system overcomes the fixed error of single frequency-modulated radar, and eliminates the critical speed limitation above which false indication of range and speed occur. However, it is complicated and has a lower maximum working range for a given transmitted power. Experimental results showed that the accuracy of the double-modulated system deteriorated quickly as the range became very short, and that the adjustment of the apparatus was critical. A new system giving the advantages of the double-modulated system but having a longer working range and high accuracy at short range, together with simpler construction and greater stability in functioning, is proposed in the final chapter.

Electromagnetic Principles of the Dynamo. By E. B. MOULLIN. *Oxford University Press (Geoffrey Cumberlege), Amen House, Warwick-square, London, E.C.4.* (50*s.*) (Reviewed on page 689, in the issue of November 18.)

Education and Training for Industrial Management: A Critical Survey. By AUBREY SILBERSTON *Management Publications, Limited, 8 Hill-street, London, W.1.* (12*s.* 6*d.*) (Reviewed on page 689, in the issue of November 18.)

Noise-Reduction Manual. By P. H. GEIGER. Prepared under the auspices of the Office of Naval Research. *Engineering Research Institute, University of Michigan, U.S.A.* (No price given.) (Reviewed on page 657, in the issue of November 11.)

"Up Funnel, Down Screw!" The Story of the Naval Engineer. By COMMANDER GEOFFREY PENN. *Hollis and Carter, 25 Ashley-place, London, S.W.1.* (16*s.*) (Reviewed on page 689, in the issue of November 18.)

The Practice of Management. By PETER F. DRUCKER. *William Heinemann, Limited, 99 Great Russell-street, London, W.C.1.* (25*s.*) (Reviewed on page 593, in the issue of October 28.)

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Refractory Concretes. LAFARGE ALUMINOUS CEMENT CO., LTD., 73 Brook-street, London, W.1. Three items as follow: (1) Pull-out folder illustrating some of the many uses of refractory concretes and structural concretes made with Ciment Fondu. (2) Mix data and conversion tables for concretes made with high-alumina cements. (3) Lists of suppliers of suitable aggregates for refractory cements, manufacturers of proprietary Castable mixes using Ciment Fondu.

Thermal Insulation. THE BRITISH PLASTER BOARD (MANUFACTURING) LTD., Bath House, 82 Piccadilly, London, W.1. An introduction to the principles of the insulation of buildings, giving definitions and characteristic figures for making calculations. Discussion of particular problems: draughts, condensation and pattern staining; choice of materials. Illustrated booklet.

Diagnostic X-Ray Unit. NEWTON VICTOR LTD., X-Ray Department of Metropolitan-Vickers Electrical Co., Ltd., 132 Long Acre, London, W.C.2. A new diagnostic X-ray unit comprising an hydraulically-operated tilting table and a rail-mounted tube stand, which can be used for a wide range of radiographic and fluoroscopic work. Fully illustrated technical pamphlet.

Miniature Panel Mounting Instruments. MEASURING INSTRUMENTS (PULLIN) LTD., Electron Works, Winchester-street, Acton, London, W.3. Constructional and technical details of miniature moving coil and moving iron instruments and thermocouples, as well as of bench type instruments, galvanometers, ohmmeters, shunt and current transformers. Illustrated brochure.

Concrete Materials. DRAVO-DOYLE CO., Fifth and Liberty Avenues, Pittsburgh, Pa., U.S.A. "Cem-Matic" box for conveying measured quantities of cement with aggregates; empties when dump truck is raised; weather-tight, it keeps cement in good condition prior to mixing. Illustrated broadsheet and specification.

Cutting and Profiling Machines. HANCOCK & CO. (ENGINEERS), LTD., Progress Way, Croydon. Technical details of the Hancomatic oxygen cutting and profile machines, including description of the straight cutting device and moveable template carrier and flame placing applications. Illustrated brochure.

Roof Coverings and Flashings. NORTHERN ALUMINIUM CO., LTD., Banbury, Oxfordshire. Suitability of high purity for fully-supported roofing and flashings, particular advantages being long life and ease of fitting. Illustrated leaflet entitled "Noral High-Purity Aluminium for Roofing and Flashing."

Bulk Materials Handling. BLAW-KNOX CO., Pittsburgh, Pa., U.S.A. Correct use of overhead travelling bucket cranes. Excerpts from a paper by Mr. A. Hooper (of the company's Equipment Divison) to the American Institute of Electrical Engineers. Leaflet illustrated by diagrams.

Transmission Screw Threads. KINGSTON ENGINEERING CO., LTD., Dansom-lane, Hull, Yorks. Thread definitions, brief descriptions of main features of square, acme, and buttress threads, extruder screws and special purpose screw threads. Illustrated booklet, "A Guide to Transmission Screw Threads."

Aluminium Overhead Systems for Railway Electrification. ALUMINIUM UNION LTD., The Adelphi London, W.C.2. Economies obtainable by the use of aluminium conductors on the overhead systems of electric railways. Technical details and prices. Illustrated pamphlet.

Solenoid Valves. EDWARDS HIGH VACUUM LTD., Manor Royal, Crawley, Sussex. Magnetically-operated valves for high vaccum system. Admittance and isolation types and selenium rectifiers for use in conjunction with them. Leaflet C 100/4.

Bevel Gears. BARR AND STROUD, LTD., Anniesland, Glasgow, W.3. Prospectus indicating company's capacity for designing and making precision cut bevel gears, including spiral, zerol and hypoids. Illustrated leaflet.

Refractory Linings. THE MORGAN CRUCIBLE CO., LTD., Battersea Church-road, London, S.W.11. Savings effected by using low-heat storage refractory linings M.I. 23, M.I. 26, and M.I. 28. Pamphlet, "A New Way of Looking at Fuel Economy."

Vacuum Gauges. EDWARDS HIGH VACUUM LTD., Manor Royal, Crawley, Sussex. Gauges for measuring vacua down to 10^{-6} mm. of mercury. Various types for different ranges. Leaflet D111/2.

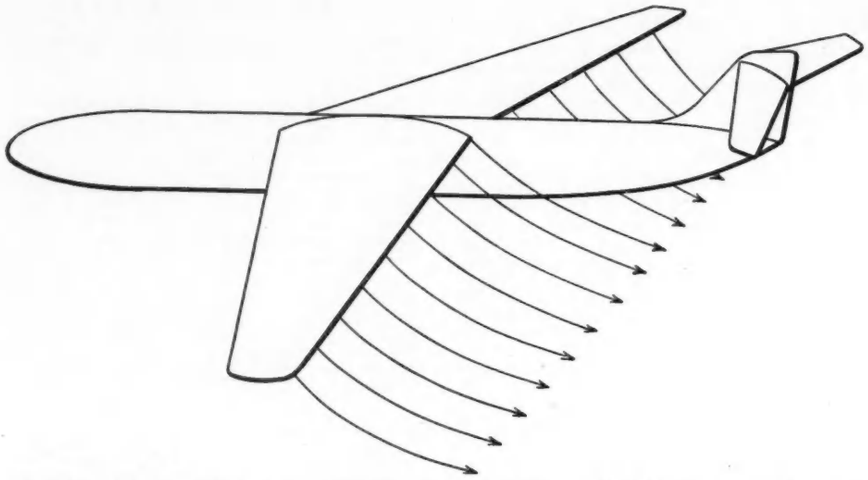

Fig. 1 Principle of the jet flap: the entire jet is ejected as a thin full-span sheet, which can be deflected to give the required lift.

LONG-RANGE FLIGHTS BETWEEN CITY CENTRES?

PRINCIPLE OF THE "JET FLAP"

As the power/weight ratio of the aero gas turbine has been progressively raised, the possibilities of using its thrust as a direct means of lifting an aircraft off the ground, and eliminating long runways, have begun to be explored, by propeller-driven "tail sitters"—the Lockheed Neptune and the Convair Pogo—and by vertical take-off jet craft—the Bell VTOL, with swivelling propulsion turbojets, and the Rolls-Royce flying "bedstead" which its manufacturers envisage as the proving vehicle for the control system of an aircraft in which a pattern of small vertical turbojets independent of the main propulsion engines would lift the aircraft vertically off the ground and sustain it during its landing.

All of these expedients have, frankly, appeared to be rather clumsy and expensive approaches to the take-off and landing problem, involving either potentially hazardous transitions from the vertical to the horizontal, or the carriage of a high proportion of unused weight during cruising flight. At Farnborough this year for the first time the National Gas Turbine Establishment revealed another possibility which, although at present only in the very early experimental stages, appears to offer a much more logical solution. We refer to the jet flap.

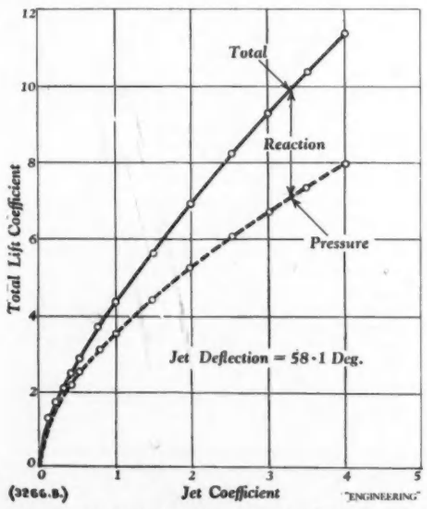

Fig. 2 Variation of lift at zero incidence with jet coefficient.

Further details of this development have been given recently in a lecture by Mr. I. M. Davidson, of N.G.T.E., before the Royal Aeronautical Society in London. The jet flap, in effect, integrates the lifting and propulsive systems of an aircraft, the entire jet being ejected as a thin full-span sheet from the wing trailing edge (Fig. 1.) Basically, the gas stream from the deflected jet flap acts like a large Fowler flap, baulking the main stream and forcing it over the wing, thus generating aerodynamic lift and also adding a reactive component.

The importance of this development lies not only in the very substantial lift coefficient gains, as shown in Fig. 2, but also arising from the jet entrainment effect on the main airstream, in the fact that it may be possible to produce an unstallable aircraft, and certainly an aircraft controllable well below the minimum drag speed. Since N.G.T.E's experimental work has to far been confined to two-dimensional model tests, it is impossible to say just what the induced drag penalty of a jet-flapped wing will amount to, but it is expected to be substantially less than that of a conventional wing with the same conditions of loading.

As regards the thrust, Mr. Davidson considers that the duct loss incurred in the jet flap installation might reduce the gross thrust in cruising flight by some 10 per cent. He does not expect the mixing of the jet stream with the main airstream to give rise to any appreciable drag in cruising flight, since whether there is a gain or a loss in thrust resulting from entrainment effects depends upon whether the density-velocity product of the jet stream is less or greater than that of the main stream, and in cruising flight it is in fact usually about the same.

At take-off and landing, the jet drag arising from entrainment increases rapidly with the jet deflection angle; but with moderate deflection angles and with good design it may be possible so to arrange the mixing of jet stream and airstream in a region of low pressure that, in principle, an increase in thrust can be obtained. This has not yet been proved experimentally.

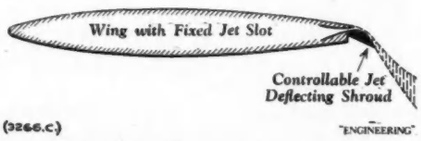

Fig. 3 Jet deflection can be brought about by a small hinged trailing-edge flap.

In discussing the application of the jet flap to the airliner, Mr. Davidson made it clear that it was far too early to forecast the shape of things to come. He suggested tentatively that such an aircraft might have, for instance, eight individual engines each powering one-eighth of the wing area, and drawing air through a leading-edge slotted intake (which would improve flow conditions over the wing in low-speed flight). Jet deflection would be brought about by a small hinged shroud at the trailing edge (Fig. 3), and these shrouds would be used for longitudinal and lateral control in crusing flight, by simultaneously or differentially controlling the deflection on either side of the fuselage. The tailplane would serve only as a trim control, and directional control would be by a conventional rudder.

Clearly there must be some snags accompanying the prospective advantages of the jet flap; Mr. Davidson foresees the possibility of lateral control difficulties arising from unsymmetrical gusts—a marked swing accompanying the corrective action to a dropped wing.

What happens to the aircraft if power fails? To safeguard against fuel running out, Mr. Davidson suggests an emergency five-minute fuel supply to be used only for final approach and landing after a long unpowered glide. In the event of an engine cut during take-off and landing, the necessary thrust margin would depend primarily on the number of engines employed and should present no fundamental difficulty. The most embarassing result of an engine cut would be control of the ensuing yawing and rolling moments, and because these would be very high for an outboard engine failure, it would be necessary to cross-couple the outboard engine fuel systems so that both outboard engines would shut down together.

In the present state of knowledge, Mr. Davidson foresees, for an aircraft of 150,000 lb. take-off weight, the possibility of take-off and landing over a 50 ft. obstacle in 500 yards, allowing a good margin on climb-out and approach speeds to cater for the contingency of engine failure. With increasing knowledge and the possibility of cutting down these margins, "a city-centre airport is conceivable even for the 500 knot trans-oceanic aircraft."

Such an aircraft will not, however, be seen in the skies for many years to come. As Mr. Davidson says, "Before the jet flap principle can be applied properly much of the theory and practice of low-speed flight must be written anew for, aerodynamically speaking, the situation is akin to that which prevailed in or about the year 1900." We may suppose that the N.G.T.E. have decided to make public in these early stages the possibilities of the jet flap in the hope that forward-thinking aircraft and engine designers may begin to ponder and come to grips with the structural and mechanical problems involved while the necessary aerodynamic data are built up.

★ ★ ★

BUILDING A STEEL FOUNDRY AT DERBY

Under the title, "Lloyds at Derby," a sound film depicting the building and equipping of a modern steel foundry was shown recently in London. As the title suggests, the promoters were Messrs. F. H. Lloyd and Company, Limited, Wednesbury, South Staffordshire, and the film deals with the construction of new buildings and the installation of plant at the works of Parker Foundry (1929) Limited, at Derby, of which company Messrs. Lloyd are the proprietors. The film, which takes 35 minutes to run, has been made by the Big Six Film Unit, 162 Brompton-road, London, S.W.3, and we understand that copies of it have been sent to more than 60 countries where it will be shown to prospective buyers of United Kingdom engineering goods.

TESTING THE RELIABILITY OF COMPLICATED MACHINES

A METHOD TO LIMIT THE COST OF PROTOTYPE TRIALS

By G. Morris, PH.D., F.INST.P.*

The purpose of the following article is to present a systematic method for the study of reliability data obtained during the development trials of complicated machines. In addition, an idealised model representing any prototype system is proposed and the appropriate mathematics developed; it is found that for two machines and for a chemical plant the failure rate can be duplicated by a very simple model of only two parts. The author suggests that most development trials are continued long past the point at which improvement in reliability justifies the cost of proceeding; and appeals for development logs of other machines in order to ascertain whether the simple models described suit a wider range of examples.

TRIALS PROLONGED UNECONOMICALLY

The present tendency in machine design is for greater and greater complexity. This increase in complication necessarily carries with it decreased reliability unless the reliability of the components is relatively very great. If the chance of failure of each part is p_1, p_2, p_3, etc., the chance of failure of the whole machine P is given by

$$1 - P = (1 - p_1)(1 - p_2)(1 - p_3) \ldots . (1 - p_n) \quad . \quad . \quad . \quad (1)$$

Continued development can produce the required reliability; for example, a four-cylinder motor-car engine on the average fails about once every 7,000 miles, equal to 10^7 cycles of the engine. If there are 200 working parts the average chance of failure of a component is once in 2×10^9 cycles; this is the result of over 50 years development.

When a new machine is designed it is customary to build a prototype, and to run it in order to assess the degree of reliability attained. In the writer's view, such trials are frequently prolonged far beyond the economic point, that is beyond the point at which the value of the information given by the trial justifies the cost of testing. It is the purpose of this paper to set out criteria for the assessment of the trials data as they are obtained, so that the cost of the trial may be minimised.

IDEALISED MODEL

It is obvious that equation (1) contains far too many unknowns to make it of any practical use, but it may be simplified for an idealised model in which the faults are considered to fall into a small number of families, the faults in each family being considered as equally likely to occur.† For the first family, which we may call primary faults, $p_1 = p_2 = p_3 = p_n = p_1$, with similar families p_2, p_3, etc. Then equation (1) reduces to

$$1 - P_1 = (1 - p_1)^{n_1} \quad . \quad . \quad (2)$$

which, if $n_1 p_1$ is so small that its squares and higher powers may be neglected, becomes

$$P_1 = n_1 p_1 . \quad . \quad . \quad (3)$$

The average number of cycles of the machine which will occur between faults **X** will be equal to $\frac{1}{P_1}$. In practice there will be a wide scatter due to statistical reasons in the value of X, the observed number of cycles between faults, but **X** the mean value should be given by equation ().

In the trial of a prototype, as failures occur, it will be necessary to take remedial action, which, it is hoped, will remove that particular cause of failure. It will be assumed here that the remedial action is so thorough that the machine will never fail again from this particular cause.* Consider now only the primary faults: the first will occur after a mean number of trials $\mathbf{X} = \frac{1}{n_1 p_1}$. After remedial action there will remain only $(n_1 - 1)$ causes of failure and the second fault will occur after $\mathbf{X} = \frac{1}{(n_1 - 1) p_1}$, etc.

The qth fault will thus occur after a mean total number of trials,

$$\mathbf{T}_q = \left(\frac{1}{n_1 p_1} + \frac{1}{(n_1 - 1) p_1} + \frac{1}{(n_1 - 2) p_1} \ldots . \right.$$
$$\left. \frac{1}{(n_1 - q + 1) p_1}\right) \text{cycles} \ldots . \quad (4)$$

The summation of the series $\Sigma \frac{1}{(n-r)}$ is examined in Appendix 1. As is shown there, it is nearly of exponential form, as might have been expected on first principles.

There may be several such series of faults acting independently. An interesting condition arises when n is very large: to keep np small this requires that p shall be very small. $\frac{1}{(n-r)}$ is then not very different from $\frac{1}{n}$, and no improvement in the reliability of the machine will be detected as a result of removing one particular cause of fault. F, the total faults observed, will then be linear with respect to the number of cycles executed.

The combination of a curve such as is given by equation (4) with a similar curve and with a straight line is illustrated by the graphs which appear in Fig. 1. The discontinuities introduced by the simultaneous action of two independent sets of causes are clear.*

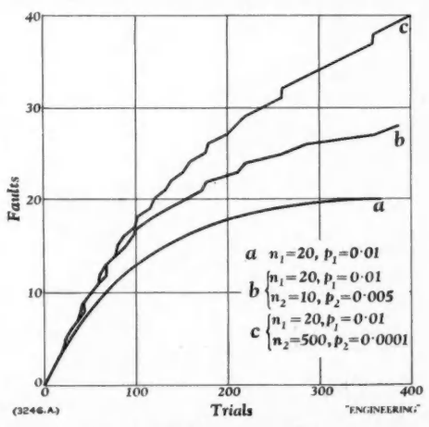

Fig. 1 Graphs relating theoretically the mean total number of trials (Tq) performed on a machine with the number of faults (q) occurring during those trials, for three sets of conditions (see equation 4). The manner in which discontinuities are introduced by the action of two independent sets of conditions is indicated by curves b and c.

DIFFERENT TYPES OF TRIAL

A different type of trial, which must be distinguished from a prototype trial, is the proving trial, which is made before handing over a machine to a purchaser (the trials of a new ship are an example). In this case, should any defect appear, the faulty part is replaced by a spare of nominally equal performance, and F is then linear with respect to **T**.

Usually a prototype trial will be run by the designers of the machine, who will be fully familiar with its construction, purpose, and intended method of functioning. Sometimes, however, a proving trial is run by a crew to

* The ideas set out above take no account of wear, which should not seriously affect such a trial. It is thought that its effect will be to make the linear portion of the graph curve upwards exponentially. No evidence on which to test this supposition is available to the author.

TABLE I.—*Comparison of the Observed Failures in a Development Trial with the Values Calculated for a Simple Model*

Number of Faults F	Observed Number of Trials T (in arbitrary units)	T Calculated From the Model	
		F_1 $n_1 = 27$ $p_1 = 0{\cdot}00440$	F_2 $n_2 p_2 = 0{\cdot}0137$
1	8	8	—
2	12	17	—
3	13	26	—
4	30	36	—
5	58	46	—
6	64*	56	—
7	95	67	—
8	97	—	73
9	100	78	—
10	101	90	—
11	107	103	—
12	110	117	—
13	117	131	—
14	125	—	146
15	144	146	—
16	148*	160	—
17	213	178	—
18	218	197	—
19	220*	218	—
20	247	—	219
21	248	241	—
22	271	266	—
23	308*	—	292
24	334	295	—
25	351	328	—
26	359*	—	365
27	441*	336	—
28	461	413	—
29	480	—	438
30	496	471	—
31	510*	—	511
32	528	549	—
33	607*	—	584
34	664*	—	657
35	757	668	—
36	761*	—	730
37	794*	—	803
38	—	—	876
39	897*	918	—
40	911	—	949
41	922*	—	1,022
42	1,012*	—	1,095
43	1,206	—	1,168
44	1,240	—	1,241
45	1,290	—	1,314
46	1,290	—	1,387
47	1,473	—	1,460
48	1,488	—	1,533
49	1,654	—	1,606
50	1,659	—	1,679
51	1,730	—	1,752
52	2,000	—	1,825
53	2,008	—	1,898
54	2,020	—	1,971
55	2,087	—	2,044
56	2,088	—	2,117
57	2,155	—	2,190
58	2,249	—	2,263
59	2,297	—	2,336
60	2,388	—	2,409
61	2,412	—	2,482
62	2,631	—	2,555
63	2,649	—	2,628
64	2,680	—	2,701
65	2,915	—	2,774
66	2,979	—	2,847
67	3,060	—	2,920
68	3,147	—	2,993
69	3,149	—	3,066
70	3,158	—	3,139
71	3,163	—	3,212
72	3,205	—	3,285
73	3,227	—	3,358
74	3,244	—	3,431
75	3,284	—	3,504
76	3,374	—	3,577
77	3,408	—	3,650
78	3,439	—	3,723
79	3,681	—	3,796
80	3,767	—	3,869
81	3,859	—	3,942
82	3,934	—	4,015
83	4,021	—	4,088

* Values so indicated in column 2 were assumed in the analysis to belong to F_2.

* Research Department, Imperial Chemical Industries, Limited, Nobel Division, Stevenston, Ayrshire.

† See also Appendix 3.

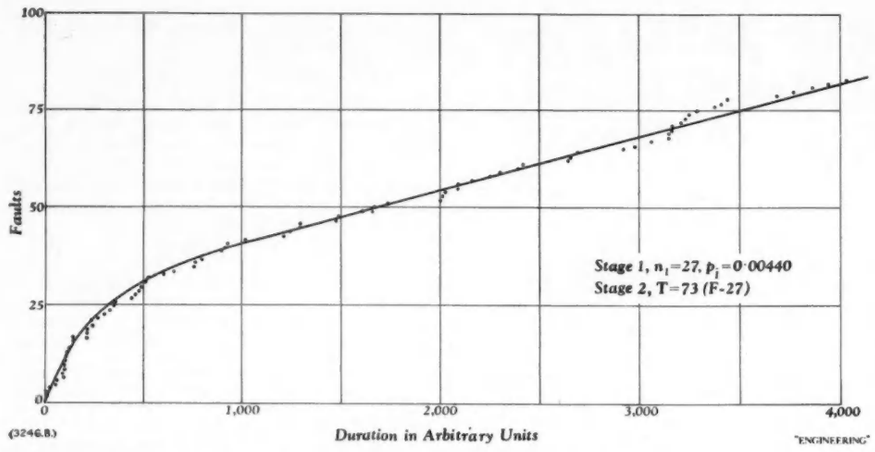

Fig. 2 Reliability of first machine in terms of faults occurring after given periods of trial. The closeness of experimental data obtained from prototype trials (plotted points) to the calculated performance of a simple idealised model based on two families of faults (curve) is very marked.

whom the machine is quite novel. The proving trial then has causes of failure which are removed as the crew becomes familiar with the methods of working, and the proving trial is then mathematically equivalent to a prototype trial, and has a curved part of its graph. Whether the operators have to be considered as a part of the machine should always be decided in performing an analysis.

The duration of the trial may be expressed in any convenient units; these may be cycles performed, hours of continuous running if the machine speed is fixed, numbers of articles produced or, for an automobile, the number of miles run.

These ideas can now be examined with particular application to three real trials, two of machines and one of a novel chemical plant.

TWO FAMILIES OF FAULTS

For the first machine the data of the prototype trials and the calculated performance of the model are set out in the graph shown in Fig. 2 and in Table I. It will be seen that the data for the model fit the experimental observations very well indeed if the statistical scatter of the latter is ignored, yet the model required to do this has very simple properties indeed, consisting solely of two families of faults, one of which contained 27 faults; all of these had been removed when the trial reached T = 1,000. Of the second family, which produces the linear part of the curve, all that can be said is that $n_2 p_2 = 0{\cdot}0137$. Since it is estimated that a 5 per cent. departure from a straight line would have been detected in the graph of Fig. 2, it may be concluded that n_2 is at least 1,120 and may be greater. Taking this smallest value of n_2, p_2 is not greater than $1{\cdot}23 \times 10^{-5}$

The early part of the trial contains faults due to both families of causes. It is possible to pick out several of the more common types of fault and attribute them positively to one of the two families.

The behaviour of the second mechanism, shown in Fig. 3, can also be represented by a simple model having only two families of faults, a primary set of 70 faults and a linear set with $n_2 p_2 = 38{\cdot}7$. As in the first example the slope of the linear part of the graph is known to better than 5 per cent., so that the 102 faults listed for the linear part of the graph cannot exceed $0{\cdot}05\, n_2$, and n_1 must be greater than 2,040.

The third set of results (Fig. 4) are for a novel chemical plant. A failure is recorded every time the plant had to be stopped to repair a defect too serious to await a maintenance shut-down. It was at first thought that this trial, like that of the machines of Figs. 2 and 3, was a development trial and would be fitted by the same type of model, but this did not prove to be the case. It was found by a study of the graph in Fig. 4, and then confirmed by inquiry, that the first period A to B constituted a proving trial in which the rate of occurrence of stoppages was far too great. From this time remedial action was not restricted to the replacement of parts by spares, but included minor redesign to improve reliability. The trial thereafter is essentially a prototype trial, and is seen to be fitted well by a simple model of two families of faults.

VALID FOR 3 DIVERSE EXAMPLES

Too much cannot be deduced from three examples, but the fact that a simple two-family model suffices to simulate each of these diverse and complex machines makes it likely that equally simple models may describe the behaviour of a high proportion of real machines during their development trials.

In all the above trials, once the linear part of the curve is reached, although some trivial information about types of fault is being found, no improvement in the reliability of the machine is being obtained from the work and expense incurred in continuing the trial. It is therefore suggested that in any prototype trial the faults should be plotted cumulatively as the trial proceeds, and that as soon as the curve is seen to become linear, the slope of the linear part should be examined to find out if the reliability of the machine is acceptable. If acceptable, the trial may cease and the machine be put into service; if not acceptable, no useful purpose is served by prolonging the trial. The indicated procedure is a complete redesign of the machine, incorporating the knowledge gained in the trial; the construction of a new prototype; and the start of a fresh development trial.

The methods so far described can be applied to a "black box" that is to say, no knowledge of the mechanism or its method of functioning is necessary. It is found, however, in practice that if the design of the machine is available, and the types of failure known, this information can be usefully employed in an analysis of the reliability of the machine.

A CALL FOR TRIAL RECORDS

A grave handicap in this investigation has been the great difficulty in finding complete logs of development trials. It is urged that engineers who may have such records available will apply to them the simple analysis used in this paper, as it seems important to discover whether many types of behaviour have to be represented in model systems, or if, as appears now, very simple models suffice. The electronics[1] and aircraft industries seem likely to have information of this kind.

The scatter of the experimental points about the calculated values would appear to be a worthwhile subject for the attention of statisticians.

It may be emphasised that this paper considers only the reliability of a machine, as measured by the frequency with which it has to receive remedial attention over and above routine maintenance. There are many factors, mostly interdependent, which must be considered in assessing the worth of any machine; these include its efficiency and rate of production, its requirement of attendant labour, its capital cost, its part in the cost of the product, and the expense of operating it. All these have deliberately been excluded from the analysis. Unless, however, a machine is reasonably reliable, its other virtues need to be considerable before it can find a welcome in a production unit.

Appendix 1

The series $\mathbf{T} = \sum_{r=0}^{r=F-1} \frac{1}{(n-r)\,p}$:

The series may be written

$$\mathbf{T} = \sum_{r=0}^{r=F-1} \frac{1}{(n-r)\,p} = \frac{1}{p}\left(\sum_{q=1}^{q=n} \frac{1}{q} - \sum_{q=1}^{q=n-F} \frac{1}{q}\right) \quad . \quad . \quad . \quad (5)$$

The series $\frac{1}{1} + \frac{1}{2} + \frac{1}{3} \ldots \frac{1}{n}$ was studied by Euler[2], who showed that

$$\sum_{q=1}^{q=n} \frac{1}{q} = \log_e n + \frac{1}{2n} - \frac{1}{12n^2} + \frac{1}{120n^4} + 0{\cdot}5772 \quad . \quad . \quad . \quad (6)$$

Since the approximation of equation (3) limits calculation to, at the most, four significant figures, only the $\frac{1}{2n}$ term needs to be considered for $n > 30$.

In practice it is very simple to sum the series

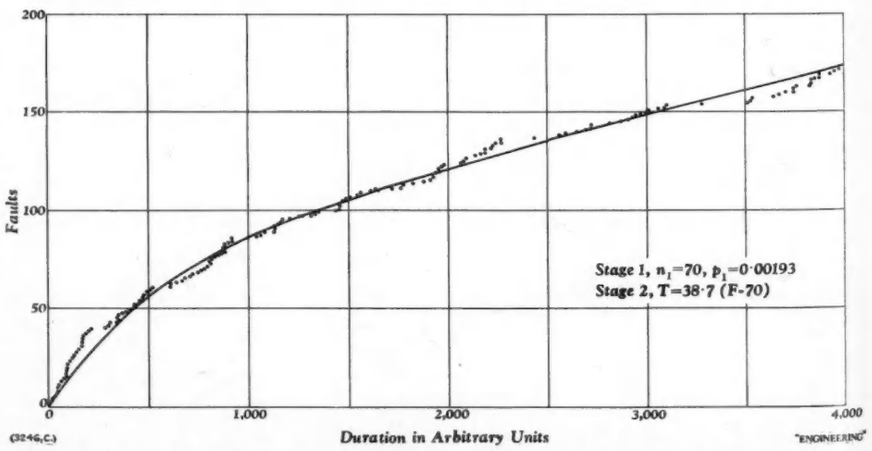

Fig. 3 The behaviour of the second machine can also be represented by a simple model having only two sets of faults. Shortly after the linear section of the graph begins the trial should be discontinued and the machine put into service or a new prototype built.

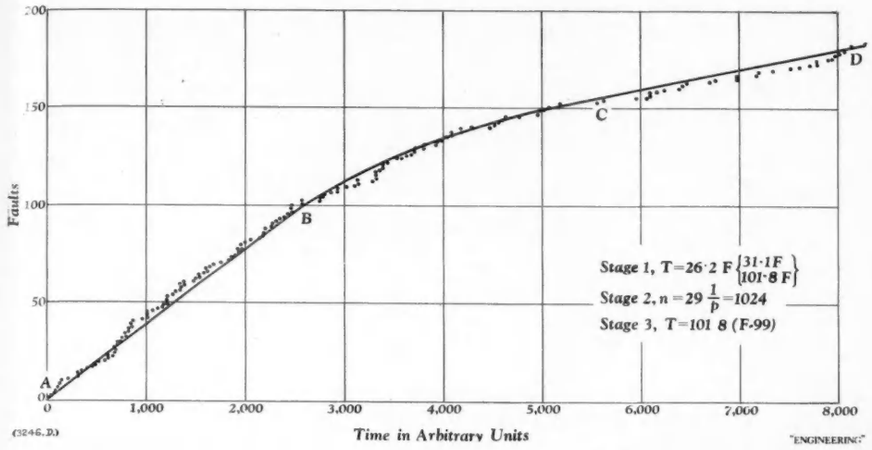

Fig. 4 Graph comparing experimental and model data for the commissioning run of a chemical plant. Although very different from machines 1 and 2, this installation proved equally amenable to theoretical treatment. The first section A to B, however, was found to be a proving period, but sections BC and CD represent the normal parts of a prototype trial.

by simple arithmetic. Table II is useful in computation.

The above expression shows why the curve relating faults and trials closely resembles an exponential. If the term in $\frac{1}{2n}$ can be neglected, we may write from equations (5) and (6),

$$p\,\mathbf{T} = \log_e n - \log_e (n - \mathrm{F}) \quad . \quad (7)$$

from which

$$\mathrm{F} = n(1 - e^{-p\mathbf{T}}) \quad . \quad . \quad (8)$$

Appendix 2

Fitting the Equations to Experimental Data of a Development Trial.—The simplest method of applying the proposed criteria to a test of a mechanism is to plot the data as they are obtained and try to decide when the graph becomes linear. This method lacks precision and will not give adequate warning of the useful end of the trial unless the statistical scatter is abnormally small. A preferred method is to assume that only one family of faults is present, and to fit a curve to these as the trial proceeds. As soon as the experimental data leave the extrapolated graph, a better approximation is fitted. After two or three such fits, the emergence of a linear portion will be quite clear.

One method of finding n and p from early data is to draw the best fitting curve through the experimental points and from this to read off $\mathbf{T}$ for each fault, and then to calculate $\mathbf{X}_b = \mathbf{T}_{b-1} - \mathbf{T}_b$. Tabulate $\frac{1}{\mathbf{X}}$. Then using the method of zero sums, since $\frac{1}{\mathbf{X}_F} = (n - \mathrm{F})\,p$,

$$\sum_0^a \frac{1}{\mathbf{X}} = a\,n\,p - p \sum_0^a \mathrm{F}, \quad . \quad (9)$$

from which

$$p = \frac{\sum_0^a \frac{1}{\mathbf{X}} - \sum_{a+1}^{2a} \frac{1}{\mathbf{X}}}{\sum_{a+1}^{2a} \mathrm{F} - \sum_0^a \mathrm{F}}. \quad . \quad (10)$$

The denominator is always equal to a^2; $n\,p$ can then be found from equation (9). Having $n\,p$ and p it is easy to find $\mathbf{T}$. Items can be tabulated as follows :

$n\,p$	$\frac{1}{n\,p} = \mathbf{X}_1$	$\mathbf{X}_1 = \mathbf{T}_1$
$(n-1)\,p$	$\frac{1}{(n-1)\,p} = \mathbf{X}_2$	$\mathbf{T}_1 + \mathbf{X}_2 = \mathbf{T}_2$
$(n-2)\,p$	$\mathbf{X}_3$	$\mathbf{T}_2 + \mathbf{X}_3 = \mathbf{T}_3$
$(n-3)\,p$	$\mathbf{X}_4$	$\mathbf{T}_3 + \mathbf{X}_4 = \mathbf{T}_4$
.	.	.
.	.	.
.	.	.
p	$\mathbf{X}_{n-1}$	etc.
0	∞	∞

An alternative way of finding p and n is to find graphically secants to the smoothed curve through the experimental data, since the slope of the secant between the rth and the $(r+1)$th fault equals $(n - r)\,p$. On plotting the slopes against r on a separate graph, the best straight line can be drawn; its slope gives p directly, while the intercept on the axis gives $n\,p$.

When the data of a completed trial are available and it is desired to evaluate the numerical constants of the equivalent model, the procedure is simpler. The data are plotted and inspected for a linear portion. If this is present the best straight line through it is found, graphically, by the method of least squares, or by the method of zero sum. The writer prefers the last as being less laborious than least squares, and more precise than a graphical method. The intercept of this straight line on the F axis gives n. The slope of the straight line gives the number of cycles per fault for its family of causes.

The mean number of cycles at which faults due to this family will occur for 1, 2, 3, 4, etc., faults can be tabulated. The experimental data are then examined, and the faults which occur most nearly at these numbers of cycles are ascribed to this family of causes and are eliminated. The remaining experimental data are assumed to belong to one other family, and are replotted, the F number of each fault is, of course, now different owing to the faults which have been eliminated. The constants of this family can be found by either of the procedures described above. Since n is now known, another way is to calculate p for each experimental value using Table II. When satisfactory values of n and p have been determined, the required F, T values can be obtained by the tabular procedure above. The two sets of calculated values, linear and curved, are then plotted over the experimental data and the quality of fit determined.

Instead of plotting the cumulative faults against the duration of the trial, it is illuminating to plot the rate of occurrence of faults. The graph will fall from a high initial value to a line parallel to the T axis, which of course represents the linear part of the graphs in Figs. 2, 3 and 4. This approach is adopted by Ryerson,[1] in considering the reliability of electronic devices. Ryerson assumes apparently intuitively that the early part of the graph is exponential (cf. Appendix 1).

This procedure is difficult to apply in the face of a large experimental scatter unless the data are arbitrarily grouped together, a process which increases the work and may lose useful information.

Appendix 3

Relaxed Restriction in the Model.—In obtaining equation (2) the model was assumed to consist of several independent families of faults, each of which consisted of n_{f_1} causes of failure of a probability of occurrence p_{f_1}. It can be shown that to the required accuracy the same result would have been obtained if the probability of occurrence of the faults were spread into a "spectrum," provided that the distribution of probabilities in that "spectrum" were symmetrical about the mean probability.

For any family, instead of equation (2) it is possible to write (dropping the subscripts)

$$(1 - \mathrm{P}) = (1 - p)^{n_0}\,(1 - (p + \Delta_1))^{n_1}\,(1 - (p - \Delta_1))^{n_1}\,(1 - (p + \Delta_2))^{n_2}\,(1 - (p - \Delta_2))^{n_2}\,(1 - (p + \Delta_3))^{n_3}\,(1 - (p - \Delta_3))^{n_3} \text{ etc.},$$

TABLE II.—Summation of the Series $\Sigma\frac{1}{q}$

q	$\frac{1}{q}$	$\Sigma\frac{1}{q}$	q	$\frac{1}{q}$	$\Sigma\frac{1}{q}$	q	$\frac{1}{q}$	$\Sigma\frac{1}{q}$
1	1·0000	1·0000	41	0·0244	4·3029	81	0·0123	4·9778
2	0·5000	1·5000	42	0·0238	4·3267	82	0·0122	4·9900
3	0·3333	1·8333	43	0·0233	4·3500	83	0·0120	5·0021
4	0·2500	2·0833	44	0·0227	4·3727	84	0·0119	5·0140
5	0·2000	2·2833	45	0·0222	4·3949	85	0·0118	5·0257
6	0·1667	2·4500	46	0·0217	4·4167	86	0·0116	5·0374
7	0·1429	2·5929	47	0·0213	4·4380	87	0·0115	5·0489
8	0·1250	2·7179	48	0·0208	4·4588	88	0·0114	5·0602
9	0·1111	2·8290	49	0·0204	4·4792	89	0·0112	5·0715
10	0·1000	2·9290	50	0·0200	4·4992	90	0·0111	5·0826
11	0·0909	3·0199	51	0·0196	4·5188	91	0·0110	5·0936
12	0·0833	3·1032	52	0·0192	4·5380	92	0·0109	5·1044
13	0·0769	3·1801	53	0·0189	4·5569	93	0·0108	5·1152
14	0·0714	3·2516	54	0·0185	4·5754	94	0·0106	5·1258
15	0·0667	3·3182	55	0·0182	4·5936	95	0·0105	5·1364
16	0·0625	3·3807	56	0·0179	4·6115	96	0·0104	5·1468
17	0·0588	3·4396	57	0·0175	4·6290	97	0·0103	5·1571
18	0·0556	3·4951	58	0·0172	4·6463	98	0·0102	5·1673
19	0·0526	3·5477	59	0·0169	4·6632	99	0·0101	5·1774
20	0·0500	3·5977	60	0·0167	4·6799	100	0·0100	5·1874
21	0·0476	3·6454	61	0·0164	4·6963	101	0·0099	5·1973
22	0·0455	3·6908	62	0·0161	4·7124	102	0·0098	5·2071
23	0·0435	3·7343	63	0·0159	4·7283	103	0·0097	5·2168
24	0·0417	3·7760	64	0·0156	4·7439	104	0·0096	5·2264
25	0·0400	3·8160	65	0·0154	4·7593	105	0·0095	5·2358
26	0·0385	3·8544	66	0·0152	4·7744	106	0·0094	5·2453
27	0·0370	3·8915	67	0·0149	4·7894	107	0·0093	5·2546
28	0·0357	3·9272	68	0·0147	4·8041	108	0·0093	5·2639
29	0·0345	3·9617	69	0·0145	4·8186	109	0·0092	5·2731
30	0·0333	3·9950	70	0·0143	4·8328	110	0·0091	5·2821
31	0·0323	4·0272	71	0·0141	4·8469	—	—	—
32	0·0313	4·0585	72	0·0139	4·8608	—	—	—
33	0·0303	4·0888	73	0·0137	4·8745	—	—	—
34	0·0294	4·1182	74	0·0135	4·8880	—	—	—
35	0·0286	4·1468	75	0·0133	4·9014	—	—	—
36	0·0278	4·1746	76	0·0132	4·9145	—	—	—
37	0·0270	4·2016	77	0·0130	4·9275	—	—	—
38	0·0263	4·2279	78	0·0128	4·9403	—	—	—
39	0·0256	4·2535	79	0·0127	4·9530	—	—	—
40	0·0250	4·2785	80	0·0125	4·9655	—	—	—

to as many terms as may be desired, where

$$n_0 + 2n_1 + 2n_2 + 2n_3 + \text{etc.} = n.$$

For any pair of terms containing the same value of Δ we have

$$[[1 - (p + \Delta_s)]\,[1 - (p - \Delta_s)]]^{n_s} = [1 - 2p + p^2 - \Delta_s^2]^{n_s}$$

In developing equation (2), terms in $n^2 p^2$ were neglected: we may therefore neglect p^2 and Δ^2. Then

$$(1 - P) \simeq (1 - p)^{n_0}\,(1 - p)^{2n_1}\,(1 - p)^{2n_2}\,\text{etc.} \simeq (1 - p)^n.$$

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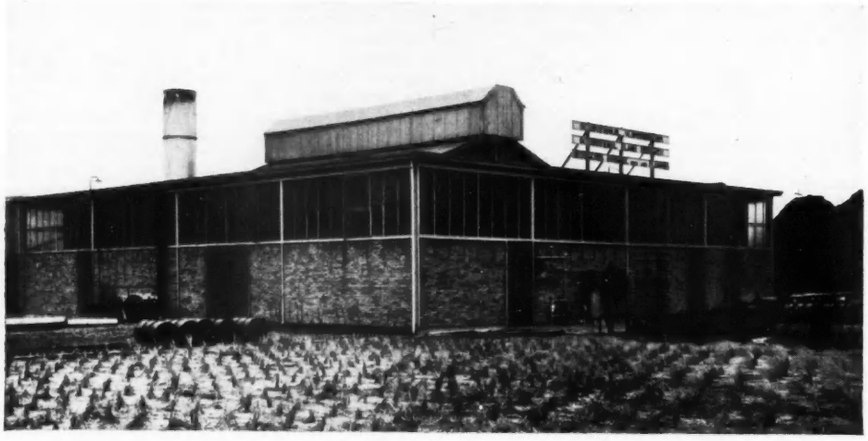

Fig. 1 Experimental station of the International Flame Research Committee. Support for the Committee's work is provided by the members not only in the form of money payments but by the loan of scientists and engineers, and by gifts of equipment.

INTERNATIONAL FLAME RESEARCH

INAUGURATION OF PULVERISED-FUEL FURNACE

A little over a year and a half ago, on April 28, 1954, the Flame Radiation Research Joint Committee—now the International Flame Research Committee—inaugurated a new experimental station on the site of the Royal Netherlands Blast Furnace and Steelworks at Ijmuiden in Holland. At that time only the first of two furnaces was completed—a unit designed for oil and gas firing, which is shown in Fig. 2—but since then a second furnace (Fig. 3), fired by pulverised coal, has also been built. The inauguration of this installation, the exterior of which can, be seen in Fig. 1, took place on November 12 of this year. On that occasion, speeches were made by Mr. A. H. Ingen Housz, chairman of the managing directors of the Royal Netherlands steelworks, Professor G. M. Ribaud, President of the International Flame Research Committee, and Mr. L. Daum, member of the High Authority of the European Coal and Steel Community, following which a paper* dealing with the problems of flame radiation in the burning of pulverised coal was delivered by Dr. D. T. A. Townend, Director-General of the British Coal Utilisation Research Association. The present article outlines the work of the International Flame Research Committee and gives a description of the new plant.

LOAN OF SCIENTISTS AND ENGINEERS

The Committee, which has been established to study the radiating properties of flames with special application to the efficient use of fuels in furnaces, owes its origin to the decision of the Royal Netherlands steelworks in 1947 to investigate the use of oil firing for steel furnaces and to build an experimental furnace for that purpose. B.I.S.R.A. in the United Kingdom and I.R.S.I.D. in France were concerned with the same problems and from the contact of these organisations arose the idea of carrying out the research jointly and on a large scale. The result was something novel in organised research—an enterprise formed for a specific purpose and run by individuals drawn from industry, Government and universities in the various countries taking part, which include in addition to the founding countries Belgium, Sweden and the U.S.A. Contributions are made not only in the form of money payments, but by the loan of scientists and engineers to carry out the work and by gifts of apparatus and materials.

In his address at the inauguration of the new pulverised-fuel plant, Professor Ribaud gave an account of the Committee's work. Immediately after the first trials, he said, the scientists engaged on this research were agreed as to the necessity of adapting and even creating the measuring instruments required to assess the value of the several variables which were to be studied within the flames, for example, velocity, temperature and composition of the gases, radiation from the flame at different points, and so on, and in view of the large number of readings which had to be made simultaneously, it was found essential to develop special recording techniques.

SUCTION PYROMETER

Some instruments gave satisfactory results relatively quickly; others required somewhat laborious development, as, for instance, the suction pyrometer (in which the flame is drawn into a refractory tube; the thermocouple is therefore not influenced by radiation from the walls of the furnace), for use with temperatures up to 1,650 deg. C., the instrument for measuring the local radiation from the flame, and the apparatus developed for the sampling and analysis of carbon particles. These prototypes have already been applied in industry.

As to the experimental work, trials were of two kinds: performance trials and scientific trials, the second comprising a more academic study of the mechanism of combustion. In the performance trials, measurements were confined to overall readings bearing on the size of the flame, and its total radiation at the different points of its passage through the furnace—measurements which were essential in assessing the heat transfer to the walls, or the load. Seven trials of this kind, each lasting between 15 days and three weeks, have been completed.

They were carried out on diffusion flames with two liquid fuels: heavy fuel oil and pitch creosote; and also with pure coke-oven gas or carburate, containing various percentages of tar products. These indicated the overall importance of the fuel jet momentum in determining the dimensions of the flame and its radiation; and made it possible to arrive at a quantitative value for the influence of the various input variables, such as the type, quantity and inlet temperature of the fuel, the type of burner and atomising agent, the steam quality, and the quantity, temperature and jet momentum of the combustion air. Industrialists, and in particular the users of transparent flames from producer-gas, coke-oven gas and town-gas installations, who would undoubtedly gain in the efficiency of gas utilisation by carburetting, could profit from these studies and many had already reported increases in efficiency due to the use of burners and atomising agents.

The Committee might have confined its work to these trials of an industrial character, but they were convinced of the need to secure a more fundamental understanding of the phenomena which existed within the diffusion flame, so that the results obtained in the Ijmuiden furnace could be extrapolated to other furnaces operating in different conditions. Such trials, called "scientific trials," or "combustion mechanism trials," implied, apart from the external measurements of the flame, a detailed study at each point in the flame of the value of the variables,

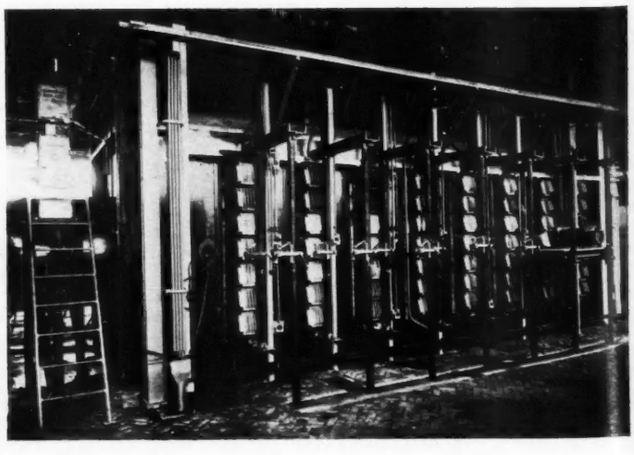

Fig. 2 Gas and oil fired furnace at the flame research station. Results already obtained have indicated the importance of carburetting in gas burning installations; and the value of burners and atomising agents in improving the efficiency of fuel utilisation.

* "The Combustion of Solid Fuels and the Aims of Flame Radiation Research in Relation to the Burning of Pulverised Coal."

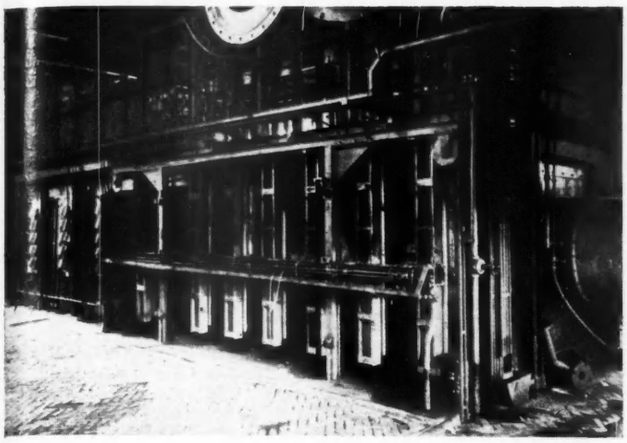

Fig. 3 A pulverised-fuel fired furnace together with associated equipment, including a coal-preparation plant and an air pre-heater, has recently been installed at the Ijmuiden experimental station. Techniques to distinguish between the various contributory factors in the total heat output have been developed.

velocity, chemical gas composition, carbon content, temperature and local radiation.

RE-CIRCULATION OF INCANDESCENT FUEL PARTICLES

With the first measurements, it became clear that the one important factor which controlled the size and the radiation of the flame was the mixing history of the combustion gas injected into the furnace with its surrounding combustion air. It was visualised, in fact, that combustion, at first taking place just on the outer periphery of the jet, could only penetrate to the interior by means of the progressive diffusion of the air towards the jet axis. Indeed, experts in fluid mechanics had already studied the relatively simple behaviour of a free jet of gas as it occurred within the unrestricted atmosphere of another gas, and they had shown in particular the important part played by the jet momentum of the injected fuel. But, in industrial practice, the problem proved to be of a more complex character; on the one hand, because of the non-uniform rise in temperature resulting from the combustion, and, on the other, owing to the fact that the products of combustion could not diffuse away into a free atmosphere, but were arrested by the furnace walls and recycled within the flame with the combustion air with which they became mixed.

High-speed cinematograph films taken during the trials clearly indicated the "re-circulation" of incandescent fuel particles projected outside the flame. It seemed clear that this re-circulation of the combustion products could not usefully be tackled by a mathematical approach, and it was necessary to study it in models, either by means of the classical methods of visualising gaseous streams or by careful analysis of the proportion of the injected gas (carbon dioxide, for instance) present in the various layers surrounding the jet. It was already possible to say that these model studies carried out in suitable similarity conditions had shown satisfactory agreement with the observations taken on the actual flame. In fact, divergencies not exceeding 15 per cent. had been observed in certain conditions, and a separate panel was at the moment studying the causes of these discrepancies.

The mixing processes were clearly not the only factors which determined the development of the various characteristics within the flame; other factors were the chemical composition and, allied to this, the temperature. At a given point, the reaction velocity, that is to say the amount of heat released per unit volume, not only depended on the local temperature, but also on the chemical composition of the mixture in the zone immediately preceding the given point, a chemical composition which proved to be very complex.

CLASSIFICATION OF FUELS

In spite of this complexity, it was nevertheless possible, with the aid of observations on real flames, together with laboratory results on the influence of temperature and various gases, such as air, carbon dioxide and steam, on the cracking of hydrocarbon particles, to establish some general relations of a comparatively simple character. These gave the quantity of free carbon at a given point, as a function on the one hand of the time taken for the gases to reach this point from the burner, and on the other of the carbon content of the fuel. As a result of this study it had also been possible to prepare a quantitative classification of fuels in terms of their ability to produce carbon particles within various types of flames. Hydrocarbons of high carbon-to-hydrogen ratio, for instance, proved, all other things being equal, to be more apt to produce free particles; such particles greatly influenced the thermal radiation.

In response to considerable demand, trials had been carried out to investigate the thermal exchanges due to convection which occurred between the flame and a cold load. The Committee had been particularly concerned with the rôle which might be played in these heat exchanges by what had become known as "convection vive." This was the convection produced by a flame in which the chemical reactions were not complete, and where completion of the reaction could be brought about in the gaseous layer slowed up by contact with an obstacle; as a result, there would be a local raising of the temperature favourable to a greater heat transfer.

A first series of measurements had been conducted; the convection coefficients measured were in good accordance with the classical formulae, and at least for the particular flames studied and with loads at relatively low temperatures, did not appear to call for the intervention of "convection vive." Further measurements would be conducted on this subject.

Professor Ribaud concluded his address by paying tribute to similar work being pursued in the various national laboratories, and by announcing that trials on the new pulverised-fuel furnace were due to begin very shortly.

EXPERIMENTAL FURNACE TO BURN PULVERISED COAL

The pulverised-fuel fired furnace, which is designed to withstand a temperature of 1,500 deg. C., is shown in Fig. 3 and is similar in design to the oil and gas furnace but with a smaller cross-section (1·5 m. by 1·5 m. as against 2 m. by 2 m.) and considerably greater length (10 m. as against 6·3 m.). It has a wall thickness of 1½ bricks comprising one brick (23 cm.) of high-quality insulation (hot face) with a special coating against ash attack and a half-brick backing of ordinary quality insulation brick. Roof and bottom are of the same composite character as the walls. The whole furnace except the roof is within a light steel casing and rests clear of the ground on a set of beams. It is therefore possible to measure heat losses through the furnace floor.

The two sides of the furnace are designed to serve different purposes; one is used mainly for radiation measurements (that illustrated), while the other is built to allow insertion of various kinds of probe. To permit the simultaneous displacement of all the radiation pyrometers up and down—a feature yielding valuable results—they are carried on a horizontal beam on which in addition are mounted the water-supply, air and wiring leads. The beam can be raised and lowered by means of two long screwed spindles which are mechanically coupled.

MOBILE RADIATION PYROMETERS

Watercooled doors, counterbalanced and interlocked with the beam, have been made to slide along two watercooled tubes, one on each side of every slot. In this way, the holes in the doors are always in line with the radiation pyrometers on the beam, and at the same time, reasonable air tightness has been secured. On the other wall fixed doors have been provided to cover the slots; these doors have seven square holes with flaps, used for introducing water-cooled probes.

On the outside of the furnace are a number of vertical pipes with sliding grips which can be used to fix in position probes or any other instruments. These arrangements make it possible to run the furnace at a controlled inward leaking air quantity down to 5 per cent.

The floor is inclined towards one side and small doors are provided on this side to facilitate ash removal. As the quantity and location of the ash deposits in the furnace and stack are unknown beforehand, and also the way in which the difficulties with loose or solidified ash will present themselves, the furnace design has been made so flexible as to be able to cope with such eventual problems.

The average load of the furnace is of the order of 250 kg. of coal per hour; by means of water-cooled pipes to be introduced through holes in the roof, the thermal load of the furnace can easily be varied between 20 per cent. and 70 per cent of thermal input. The furnace is also equipped with oil-burning facilities for heating-up purposes.

AIR PRE-HEATING

The installation also incorporates an air pre-heater and a coal preparation plant, the purpose of which is to provide the furnace with dry pulverised fuel of widely different characteristics. It must therefore have maximum flexibility, and the separate operations of crushing, drying, milling and weighing are interconnected through storage hoppers. The capacity of the plant is 500 kg. pulverised coal per hour, having a fineness of 95 per cent. through B.S. sieve 200. Both plant and furnace are able to use coal ranging from anthracite to lignite and from 8 to 30 per cent. ash content. The preparation plant also includes a drier, suction unit for dust removal, and a cyclone, which delivers the dried coal to a storage hopper.

The air pre-heater is fired by blast-furnace gas and heats the air to a maximum temperature of 750 deg. C. It is constructed of smooth alloy-steel tubes (Schack design) which are counterbalanced to permit thermal expansion. The preheated air passes through refractory-lined tubes to both furnaces.

The pulverised-fuel plant has been largely built with British equipment, and practical support has been given by Associated Portland Cement Manufacturers, the British Coal Utilisation Research Association, the Central Electricity Authority, the Fuel Research Station, the Water-Tube Boilermakers' Association and other members of the British section. The United Kingdom address of the Committee is 6 de Vere-gardens, London, W.8.

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NATIONAL AERONAUTICAL ESTABLISHMENT, BEDFORD

From December 1, the National Aeronautical Establishment at Bedford will be known as the Royal Aircraft Establishment, Bedford.

The National Aeronautical Establishment was set up in 1946 to supplement the work of the R.A.E. Farnborough. It is equipped with some of the most up-to-date wind tunnels in the world.

INSTRUMENTATION AS A SERVICE

DESIGNING AND BUILDING AUTOMATIC CONTROL SYSTEMS

Almost every large engineering project involves the use of control systems and instruments, and it is therefore not surprising that John Brown and Company, Limited, engineers and shipbuilders, and Richard Costain Limited, building and civil-engineering contractors—both experienced in large-scale construction work—should have formed a joint Instrumentation Division. This division is under the control of Costain-John Brown Limited, established in 1948 to meet the combined mechanical and civil-engineering requirements of major construction schemes for the oil and chemical industries. The division, whose services have now been available to industry at large for three years, has recently created an automatic-control development group. Its object is to study the control characteristics of chemical plants, and to provide basic information for the design of automatic control systems.

TRAINING SPECIALISTS

To handle the instrumentation and automatic control work associated with their activities in the design, construction and commissioning of chemical and oil-refining plants, Government research projects, and other large installations, Costain-John Brown Limited formed, some five or six years ago, their specialised Instrumentation Division. At that time it was foreseen that the needs of industry for automatic control services would be likely to grow, and furthermore the increasing complexity of such systems would create a demand for engineers and craftsmen who were trained in this new branch of engineering. In 1948 there were few people in the United Kingdom with specialist experience in this field, and to overcome the shortage, Costain-John Brown introduced a training scheme devoted entirely to instrumentation and automatic control.

About three years ago the services of the Instrumentation Division were made available to industry in general. Thus the present work of the division falls under two main headings: firstly a departmental service to the company, and secondly a direct service to industry at large. In addition to providing specialist teams for the installation, calibration and maintenance of instruments and automatic controls on site at home and abroad, the division undertakes the design of automatic control systems, control panels and desks, and a variety of similar items; the division also has its own works, which is equipped to assemble, pipe, wire and test units in readiness for plugging in on site. To date, some two hundred control panels, cubicles and desks have been completed; two examples can be seen in the accompanying illustrations. Fig. 1 shows a control panel for a sugar refinery built for Tate and Lyle Limited, and Fig. 2 is a wind-tunnel control desk made for the Ministry of Works. The division also produces a standard range of cubicles.

INSTRUMENT CUBICLES

In addition, the department has assembled and fitted over 150 instrument cubicles for the United Kingdom Atomic Energy Authority; designed control and alarm systems for the wind-tunnel project previously mentioned; provided instrumentation for a large explosives plant for the Ministry of Supply; fabricated control panels for Shell petroleum-refining installations; and made and installed other equipment for the oil, chemical and steel industries. At present the division is designing control systems, and procuring the instrumentation and other equipment for the company's £6½ million trans-Iranian pipeline project.

In the field of automatic process control, however, something like a stalemate has been reached. For a number of years instrument manufacturers have been producing a continuously improving product. By the introduction of new controllers plant designers and users have been able to effect considerable improvements in the performance of chemical plants. Yet the application of these instruments has been carried out largely in an empirical manner; that is to say, plant control problems have been studied in the light of experience and control systems devised accordingly.

INVESTIGATING CONTROL SYSTEMS

On the other hand, in the field of servo-mechanisms and the automatic control of mechanical equipment it has been possible to calculate control characteristics, and thus devise the best combination of mechanical characteristics and control system performance. This is possible because the data affecting the performance of the mechanical system, such as mass and inertia, are readily obtainable or can be computed.

In the case of chemical plants, however, there is a great shortage of data concerning dynamic characteristics, and these data must be obtained if automatic control systems are to be applied in a scientific way. Thus for the time being it is still necessary to design these systems on an empirical basis, and this means that major advances in automatic process control await the results of close study of plant characteristics. With this in mind, Costain-John Brown have formed an automatic control development group, the object of which is to investigate and complete data on plant characteristics, to study the performance of available automatic control apparatus, and generally to bring scientific methods to bear on problems of automatic control application.

The premises of the Costain-John Brown Instrumentation Division are at Roxby-place, Fulham, London, S.W.6.

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A SURFACE GRINDER IMPROVED

Automatic Down-Feed and Power Traverse to Wheelhead

The surface grinding machine, model 540, made by A. A. Jones and Shipman, Limited, Narborough-road South, Leicester, is now available with automatic down-feed and power traverse to the wheelhead.

The automatic down-feed is operated in conjunction with the hydraulic traverse mechanism. It is controlled by the table longitudinal-traverse gear, and is so arranged that vertical feed is applied every time the table reaches the extreme left-hand limit of travel. The amount of feed is adjustable from 0·0001 in. to 0·0005 in. per reversal. An adjustable micrometer stop, mounted on the wheelhead column, can be set to trip the automatic feed at any desired point within the normal range of vertical travel. The feed can be disengaged instantly if necessary.

Power traverse of the wheelhead, which is normally used for quick withdrawal of the wheel to facilitate loading of the work, is operated by an electric motor. A hand-lever adjacent to the vertical-feed handwheel disengages the normal feed and couples the motor to the feed-screw. Control of the motor is by two push-buttons, coloured and marked to indicate the direction of travel, and the motor continues to run as long as the appropriate button is depressed. At the limit of travel in either direction the motor is stopped automatically. A secondary trip is set to stop the traverse with the wheel clear of the work, to prevent accidental feeding of the wheel directly into the article being ground.

The down-feed and power-traverse mechanisms are completely interlocked so that neither the work nor the machine can be damaged should the wrong motion be engaged at any time.

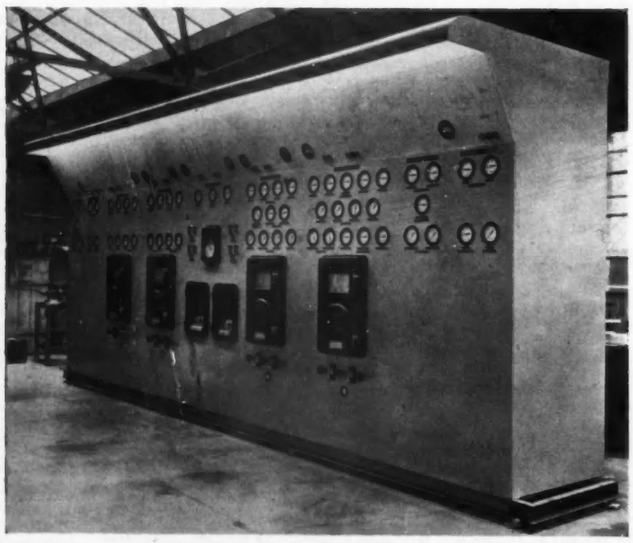

Fig. 1 Control panel for a sugar refinery made by the Costain-John Brown Instrumentation Division for Tate and Lyle Limited. Originally a company departmental service, the Instrumentation Division now serves industry in general.

Fig. 2 Wind-tunnel control desk built for the Ministry of Works. The Costain-John Brown Instrumentation Division has recently formed a special group to investigate the characteristics of automatic control systems and to assemble data for their design.

The Iron and Steel Institute Meeting at Scunthorpe (*concluded from page* 697)

LEAN IRON ORES

PROBLEMS OF MINING AND TREATMENT

Concluding our report of the special meeting of the Iron and Steel Institute which took place in Scunthorpe, Lincolnshire, from October 12 to 14, we have now to deal with the last technical session of the meeting. This was the second of the two simultaneous technical sessions held on Thursday morning, October 13. Mr. W. L. James occupied the chair.

MINING FRODINGHAM ORE

" Underground Mining of the Frodingham Ironstone Bed," by Mr. C. Smith, of the ore-mining branch of the United Steel Companies, Limited, was the title of the first paper considered. Mr. Smith stated that the Frodingham ironstone bed had been worked economically for almost a century by various methods of opencast mining. At present, however, such thicknesses of overburden were being encountered that the methods employed hitherto were becoming either uneconomical or impracticable. To safeguard against all emergencies and to ensure the continuity of the large tonnages required for future generations, underground mining methods had been introduced, seven years ago, to work the extensive reserves still held concealed beneath the thicker cover. This, the Dragonby Mine, was expected to produce at least 1,000,000 tons of ore per annum for many years from a large area which otherwise might not have been worked.

COSTS AND LABOUR

Mr. G. H. Johnson, who opened the discussion, said that he accepted without question that recourse to the underground method of extraction in the Dragonby area had been dictated by the fact that, as the workings were driven forward in an easterly direction, following the general dip of the bed, the depth of cover increased to a thickness impracticable for opencast working. Mining men would like to know, however, what actual percentage of the bed would eventually be recovered in what were essentially mining propositions.

One of the problems facing producers from below ground was likely to be a shortage of personnel. Mining, and, in particular, highly-mechanised mining, was a specialised task requiring trained personnel, and there was a disinclination on the part of the youth of the country to-day to enter the mining industry.

Mr. T. M. Dover suggested that the limit of opencast mining was entirely one of economics. The advent of scrapers drawn by wheeled and tracked tractors had completely revolutionised the thinking of mining engineers on opencast working, and " practicability " was an almost impossible term to define since the length of haul was only limited by economic considerations. Mr. Smith had stated that an area had been chosen which because of its depth could not be worked by opencast mining. The economic considerations which limited opencast working were extremely difficult to formulate. It has been suggested that opencast working of very deep overburden could not be contemplated on account of the difficulty of restoration. The experimental plot operated by the Ministry of Agriculture at Roxby had shown that better crops could be grown on restored lias clay overburden than on the original sandy surface in the Frodingham district. The lower output per man obtained underground was also a serious matter if very large quantities were to be obtained by this method.

Under " Manpower " and " Outputs " Mr. Smith had shown that 10,000 tons a week could be expected with 120 men, an output of 84 tons per man-week. The comparable figure for opencast working was about 140 tons per man-week. As to the consumption of explosives, underground, 1 lb. of explosives produced 1·4 tons of broken ore; by opencast, 1 lb. of explosives produced from 4 to 6 tons of ore.

Mr. L. Highton said that he was not at all happy that the ultimate solution for taking the ore away from the face had been arrived at. The ore was loaded with a machine which had been developed for coal. It was an American machine, and it had been developed for working with soft coal in America. The ore was loaded into a shuttle car and some 17 tons were obtained per man shift. There was already in existence, in this country, a mine which was getting some 25 tons per man shift, using a form of shovel loader, which was now available, and a Yukon truck.

Mr. Smith, in reply, said that it was unfair, at this stage, to try to compare the economics and other factors of a mine like Dragonby and opencast methods. Not a single opencast mine in this country was stripping 200 ft. or more of comparable overburden. There was a great deal of difference between the economics of an overburden of 30 to 40 ft. and one of 200 ft.

The difficulty at Dragonby might not be in removing the soil. This soil was a peculiar type of clay, and *in situ* a tunnel could be driven or a hole bored, through it, and it was nice consolidated material. Once it has been opened and exposed to atmosphere, however, and water had been allowed to get into it, its texture became like that of soft soap, or " greasified lubricant." The question was not how much could be moved economically, but where it was to be put when it had been moved and whether it would stay where it was put.

Turning to output per man shift, with the present small set-up, they were producing 10·5 tons a man, including the night watchman and the washing-up man—every one of their 120 employees. That was the overall figure. For March and June they had managed to put the output, per manshift, up to about 11·8 tons, because there had been some good outputs.

TREATING LOW-GRADE ORES: RECOVERING VANADIUM

The second and last paper considered at the meeting was entitled " Development of Chemical Treatment of Low-grade Iron Ores at Appleby-Frodingham," and was by Dr. L. Reeve, chief metallurgist, Appleby-Frodingham Steel Co. The author stated that the home-produced iron ores used in the Appleby-Frodingham blast-furnaces were the lowest grade iron-bearing materials employed on an industrial scale anywhere in the world. Nevertheless, despite the production of 26 cwt. of slag for every ton of iron made, the coke consumption and outputs of the furnaces using these ores had been improved to a degree which made them comparable with practices using much richer ores. This had been achieved by extensive ore preparation, and, in particular, by the application of improved sintering techniques to the maximum degree possible.

The feasability of concentrating the ores to raise their iron content had been the subject of consideration and experiment at Appleby-Frodingham for a good many years.

The results had shown that the ferric-iron content of low-grade ore could be distilled almost completely as pure ferric chloride by treatment in hydrogen chloride gas at temperatures of approximately 300–350 deg. C. All other major constituents, including sulphur and phosphorus, remained in the tailings. The ferric chloride so produced could be hydrolysed by steam, at 300–350 deg. C., to produce ferric oxychloride and finally, by further steam treatment, at 550 deg. C., to produce pure ferric oxide, with the regeneration of HCl gas, for use in chloridising further supplies of ore. Alternatively, the ferric chloride could be treated with hydrogen-containing gases to produce metallic iron and hydrogen chloride.

Experiments first conducted in 1949 had indicated that the processes outlined were most conveniently carried out on finely-crushed ore, fluidised in a stream of reactant gases.

The vanadium content of the ores was distilled in HCl gas simultaneously with the chloridising of the iron, and could be recovered finally as pure V_2O_5.

Before the processes could be developed to anything like an industrial, or even a pilot-plant scale, the question of suitable materials of construction for the reaction vessels had to be considered. It had been found that unlined mild steel could be used for reactors and ducts in contact with HCl gas at temperatures up to at least 350 deg. C., even in the presence of water vapour, provided that the gas mixture was above the dew point. At high temperatures, brick-lined mild steel or stainless steel could be used. Where condensation was unavoidable, glass or carbon tubes had been found to give satisfactory service. Polythene and other plastic tubes and linings had also found extensive use.

SPONGE IRON AS THE END PRODUCT?

Mr. D. A. Oliver, C.B.E., in opening the discussion said that only a week or so previously, the Institution of Mining and Metallurgy had been debating the need, or otherwise, of a national or commonwealth minerals policy, and, on the technical side, the desirability of creating a national mineral dressing and process metallurgy laboratory. It had been generally thought that this country had slipped behind a little in modern extractive methods as applied to minerals. It was a pleasure, therefore, to welcome Dr. Reeve's paper as one of the exceptions which disproved the general rule.

The possibility of recovering vanadium from indigenous ores was of great potential importance in itself, as at present we, in this country, relied largely for our supplies on V_2O_5 from Belgium, where it arose as a by-product in the refining of lead-zinc concentrates.

Although little was said in the paper as to the possible economic value of vanadium recovery, such a process could be of great long-term significance to this country.

He would like to know from Dr. Reeve whether it was the present intention to try to industrialise the process in a larger plant, or whether it was proposed to follow some of the other alternatives, namely, to try to find sponge iron as an end product. Sponge iron in either a pure or a carburised form could be taken straight to the steel furnace, as distinct from going through the pig-iron stage.

The only other speaker, Mr. E. W. Voice, said that the ore used had been crushed to 30-60 mesh and the chloridising reaction times quoted were 1–1½ hr. Would there not possibly be advantages in reducing those reaction times to minutes or even to seconds by using much more finely-divided ore?

There was very little reference in the paper to the physical state of the ferric oxide produced. Was it a very fine powder or was it granular and if so what was the particle size of the pure ferric oxide produced?

Dr. Reeve, in reply, said that Mr. Voice had asked: Why not reduce to a smaller size and get an increase in reaction rate? There were two answers. The basic problem on the economics side was not strictly the reaction rate, even though it took 1–1½ hr. It was simply a question of the depth of the beds employed. The equilibria were the real problem and the fact that large volumes of gas had to be used.

The volume of the gas was the really serious problem. Heat recuperation was equally a problem, particularly where HCl acid has to be condensed. A condenser-evaporator system was quite big and expensive. It was necessary, therefore, to try to reduce the volume of gas required, and this was what they were aiming at.

Vanadium was an extremely important item on the credit side, and work was being done on the possibility of recovering this metal.

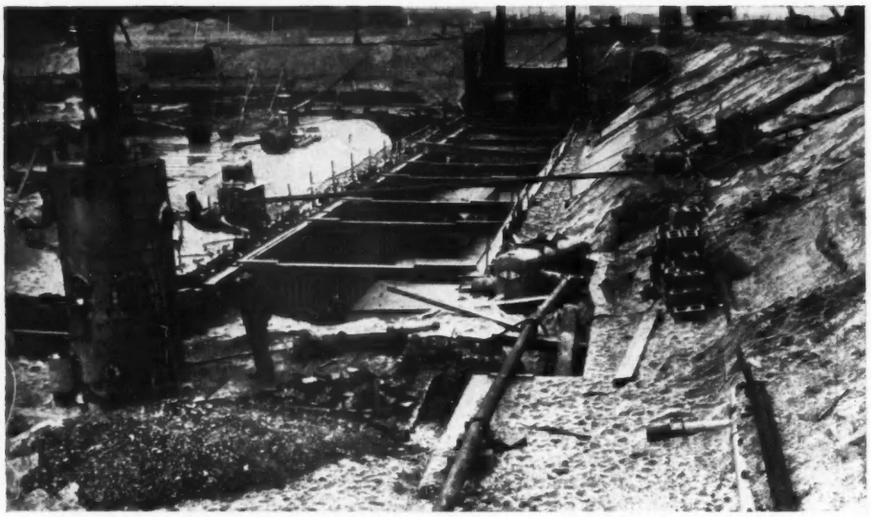

Fig. 1 Construction of the main foundation raft and excavations for cooling water conduits at South Denes power station, Yarmouth, where Blaw Knox wellpoint de-watering equipment is being employed.

DRAINING A WATER-SURROUNDED POWER-STATION SITE

WELLPOINTS ADOPTED AT SOUTH DENES

The South Denes power station of the Central Electricity Authority at Great Yarmouth, the ultimate capacity of which will be 240 MW, is being erected on a spit of land between the River Yare and the Yarmouth Roads (or open sea), shown in Fig. 3, opposite. Due to the presence of free water on two sides of this area, some unusual problems have had to be faced, particularly in the early stages, and it was decided to employ pre-drainage for de-watering purposes. For this purpose the wellpoint system of Blaw Knox, Limited, 90 Brompton-road, London, S.W.1, was selected, and the ground water level thereby reduced so that the reinforced-concrete raft carrying the main building (including the boiler and turbine houses), the cooling water system under the turbine house, the cooling water inlet and outlets and the inward and outward ash conduits, could all be constructed in the dry. In addition, de-watering was necessary before building the cooling water conduit leading to the sea outfall, some 800 ft. beyond high water mark.

The consulting engineers for this part of the work were Rendel, Palmer and Tritton, 125 Victoria-street, London, S.W.1, and the contractors Peter Lind and Company, Limited.

GEOLOGICAL CONDITIONS

The strata encountered below the site was composed of coarse sandy ballast below which was a band of "silty clay" and layers of ballast containing lenses of clay, which extended below formation level. This strata appeared to dip in a south-westerly direction across the site.

A major problem in connection with the de-watering was to overcome the difference in the rate of permeability of the materials in the upper and lower strata. To meet this difficulty all the wellpoints were "chain jetted," that is, a length of chain was hooked to the jetting tip. The action of this chain reinforced the normal jetting operation and enabled a cavity to be eroded round the wellpoint into which a coarse sand refill was poured. This ensured adequate filter areas round each wellpoint and the maximum efficiency in pre-drainage to be achieved. The chain was arranged so that it could be easily removed after the jetting operation.

The sieve analyses of the materials in the area are set out in the accompanying table.

TABLE I.—*Sieve Analysis of Strata at South Denes Power Station*

Passing	General Analysis Above − 4·00 Ordnance Datum Per cent.	At − 10·00 Ordnance Datum*	At − 20 Ordnance Datum
¾ in.	93	—	—
⅜ in.	63·3	—	—
¼ in. ..	53	—	—
7 mesh ..	47	—	—
14 mesh ..	42	—	—
25 mesh ..	32	99	—
52 mesh ..	6	98	84
100 mesh ..	0·6	89	14
200 mesh ..	0·2	53	3

* This strata is about 8 in. thick.

PROGRESS OF THE WORK

Work began in June, 1954, when the existing level was reduced by excavation from an average of + 12·00 to − 2·00 Ordnance Datum. The initial installation at + 2·00 Ordnance Datum comprised one line of wellpoints with 14 ft. risers. This was constructed on the south side of the main raft position, and was subsequently extended round the west side, the length of the risers being increased to 18 ft. with a short return along the north side. The ground water level was at + 1 Ordnance Datum, but the wellpoints allowed it to be reduced to − 2·00 Ordnance Datum, so that the raft of the main building could be constructed in dry conditions. This part of the work is shown in Fig. 1, in which the initial wellpoint installation can be seen running from the front at the bottom right hand corner.

COOLING WATER CONDUITS

Concurrently work on the cooling water conduits on the west side was begun, wellpoints being installed on each side of the two lines of piles. This installation, which was carried down from − 4·00 Ordnance Datum, was designed to enable wellpoints and short lengths of riser pipes to be placed on the outside of each line of piles and 25 ft. wellpoints on the inner side of the piling within the pans. The latter wellpoints were shielded during concreting so that they could easily be withdrawn. The wellpoints on each side were coupled to single header lines. The object of this arrangement was to control the flow of water in the coarse material by the short riser pipes and so to reduce the loading on the piles. The artesian pressure within the fine materials in the cofferdam was overcome by 25 ft. wellpoints. The contractors were therefore able to work in dry conditions at − 21 Ordnance Datum, as is shown in Fig. 2.

This lower system made it possible to eliminate the initial high-level wellpoints, while maintaining the water level below the formation level of the main building site. As concreting progressed the conduit installation was simultaneously advanced towards the cooling water intake and the turbine block foundations, work on which was started in February, 1955.

TURBINE BLOCK FOUNDATIONS

To construct the turbine block foundations sheet piling was driven on the outside of which wellpoints with short lengths of riser pipes were installed. Wellpoints similar to those used for the cooling water conduit were also installed on the inside. In this case, however, the risers on the outside of the piling, as well as reducing the loading on the piles, helped to overcome the flow of water into the excavation through

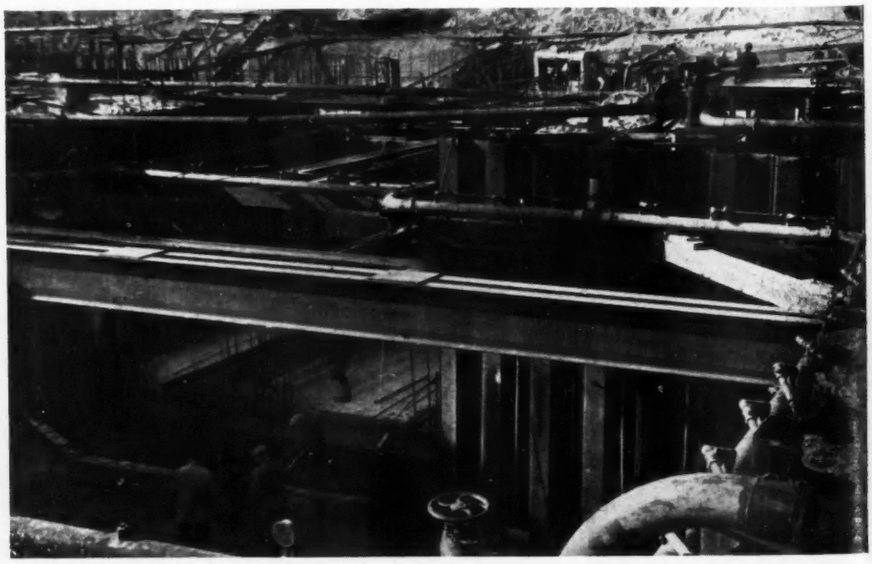

Fig. 2 Formation level of excavation at − 21 Ordnance Datum, showing the dry conditions that prevailed during construction work.

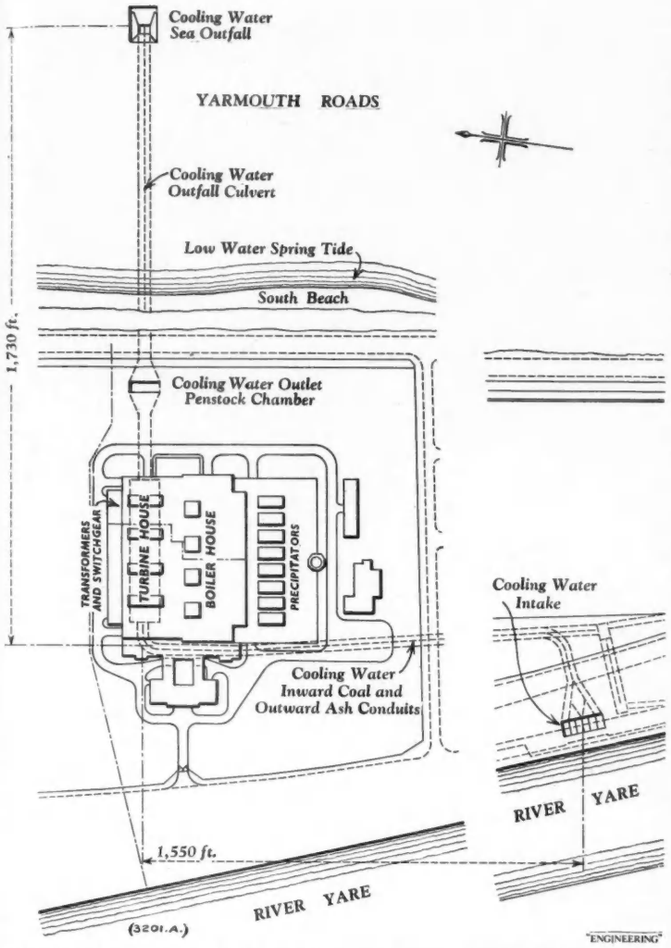

Fig. 3 Site plan at South Denes power station, showing the confined location and the proximity of the sea (Yarmouth Roads) and the River Yare.

split piling clutches caused by hard driving conditions. As before, the 25 ft. wellpoints overcame the artesian pressure within the finer materials of the lower strata. Although both sides of the excavation were sheet-piled the end towards which progress was made was necessarily left open, the water, which would otherwise have entered the excavation, being kept in check by transverse lines of wellpoints.

COOLING WATER OUTFALL

Meanwhile wellpoints were installed on the first sections of the cooling water outfall conduit, as it was driven seaward. These have not so far been employed beyond high water spring tide-mark as the material encountered is coarse and open pumping proved adequate. If, however, finer materials are met with it may be necessary to introduce wellpoint dewatering as far as the end of the 800 ft. run towards the outfall chamber, so as to avoid hazards to the piling, which might occur owing to "boiling" causing the removal of fines.

The cooling water outfall conduit at −21 Ordnance Datum showing the Blaw Knox wellpoint de-watering pump on the right is illustrated in Fig. 4.

The cooling water intake is being constructed inside a cofferdam. This cofferdam, illustrated in Fig. 5, was driven before work on the intake began. It fronts directly on to the Yare, the high water mark being at the level of the waling visible at the top of the photograph. Wellpoints were jetted inside the cofferdam at −13 Ordnance Datum to enable the contractors to found the new structure at −24·5 Ordnance Datum. Difficulty was experienced owing to water from the river finding its way into the excavation area through split piling clutches. This was, however, controlled successfully by heavy duty sinking pumps (as will be clear from the dry conditions shown in Fig. 5) wellpoints being used to stabilise the fine materials and then to overcome the possibility of serious blows or boiling.

WATER LEVEL READINGS

The extensive system of de-watering at South Denes which is described above, has also been used to obtain information. For instance, the wellpoints were jetted at strategic points and used to obtain water level readings from which hydraulic gradients could be plotted and the maximum efficient use made of the equipment.

It is interesting to note that where wellpoints were installed within sheet piling driven into the fine materials of the lower strata, there was a general fall in the water level outside the piling of about 6 ft. in six weeks. It was also found that a cessation of pumping resulted in a rapid rise of water level and that a considerable time was necessary before control could be re-gained.

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OXYGEN BY PIPELINE

Tonnage Plant for Scunthorpe

A tonnage plant, from which oxygen will be distributed by pipeline, is to be built at Scunthorpe, and is scheduled to begin production in 1957. It is expected to inspire a number of changes in the Lincolnshire coast steel industry, and will serve the growing demand for oxygen in steel works, where it is used not only in steelmaking but also for such processes as cutting and de-scaling. The plant is to be built by the British Oxygen Company, Bridgewater House, Cleveland Row, St. James's, S.W.1, and will be of the company's Rescol design.

At present the millions of cubic feet of oxygen used by the steel industry in Scunthorpe are brought from the Sheffield area, some 50 miles away. With increasing usage it has become necessary to undertake oxygen manufacture locally, and with this object in view a tonnage plant of the largest capacity has been commissioned. The term "tonnage oxygen" denotes manufacture on a large scale, exceeding that of normal industrial requirements; it also implies production in sufficient quantity to justify pipeline distribution, and to permit considerable reduction in cost.

At Scunthorpe the initial installation will comprise a plant with a productive capacity of 200 tons of oxygen a day, or about 36 million cub. ft. a week. The site will be in the Warren-road area, almost mid-way between the Normanby Park steel works and the Appleby, Frodingham, Redbourne and Firth Brown group of steel works. The plant will employ a considerable element of automatic control, and being centrally situated will enable pipeline supplies to be run directly to each company's premises.

ig. 4 Construction of cooling water outfall conduit at − 21 Ordnance Datum with the de-watering pump on the right.

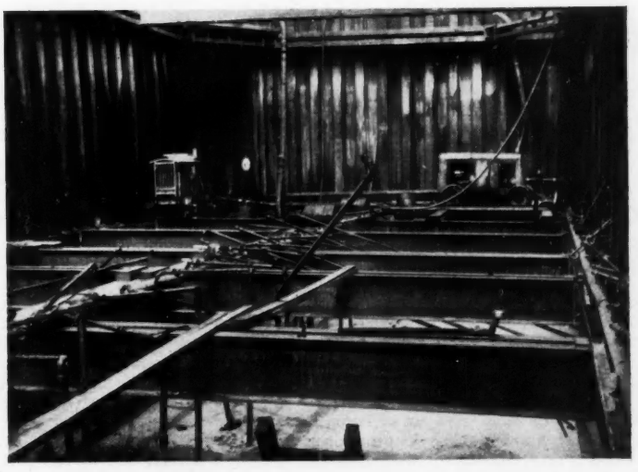
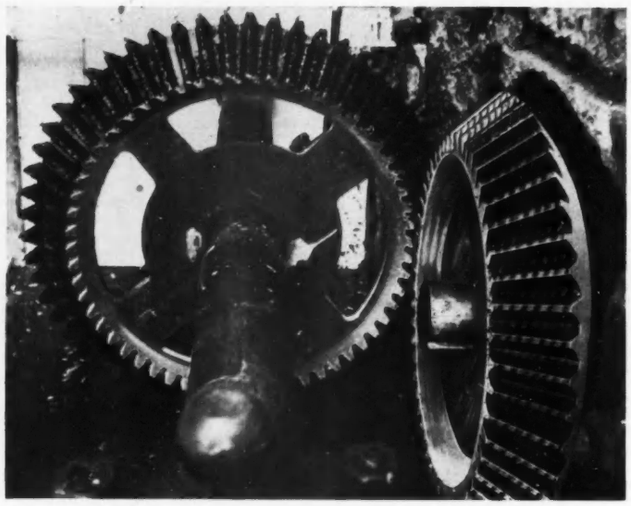
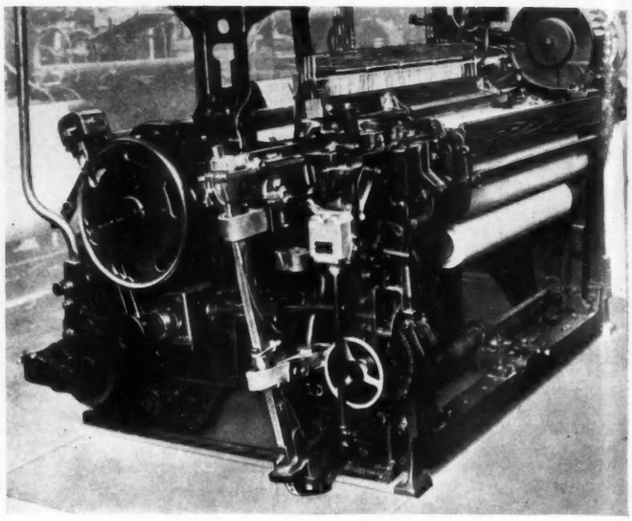


Fig. 5 Inside the cofferdam for the cooling water intake. The high water mark is at the level of the waling at the top of the photograph.



The pinion on the right is made of densified wood and is capable of transmitting 32 h.p. at 325 r.p.m. and of driving 20 looms.



A textile loom, showing the densified-wood laminated picking stick and race-boards, and the medium-density sley.

TIMBER FOR MACHINERY

ARDUOUS USES IN SPINNING AND WEAVING

The textile industry is an important part of the economic structure of this country, and the advent of the mechanical loom in the 19th Century played no small part in the Industrial Revolution. To the layman, and engineers specialising in fields other than textile machinery, the large looms will be thought of in terms of iron or steel, but in fact very large quantities of timber are used for certain parts and accessories.

Lancashire and Yorkshire are renowned the world over for the quality of their manufactured cotton, silk, rayon and woollen goods. Competition from other countries necessitates the maintenance of high-quality productions, and this can only be achieved by first-class modern plant. It follows, therefore, that only the highest grade timbers, of carefully selected suitable species free from knots, cross-grain and other defects are used for the wooden parts of the mechanism.

The cotton-spinning mule, used to make cotton thread or yarn, uses wooden bobbins on which the yarn is wound. These are generally made from birch, maple or sycamore, and the bobbins are held in position by mahogany mountings. The weaving frame has larger bobbins of the same timbers, and when subsequently wound on to the warping-frame roller the latter will be made from first-quality clear Douglas fir, and the framework of the warping machine will be of Canadian yellow pine.

Numbers of wooden vats also find their place in the mills, the boiling or sizing processing of the yarn imposing an arduous test on the pitch pine or Douglas fir from which the vats are made.

In the weaving process one of the most important devices is the shuttle; it is estimated that these travel about 10,000 miles during their average life of about six months—one of the most exacting applications to which wood can be put. Good shuttle wood must be dimensionally stable, not too heavy, say, 48–60 lb. per cub. ft. (to avoid strain on the other parts of the loom), even textured, straight grained, tough and free from defects which would, when worn, lead to a rough surface and consequently damage the yarn. Some hardwoods possess these attributes, but none are so suitable as the American dogwood (*Cornus Florida*) and persimmon (*Diospyros Virginia*), and these are acknowledged to be the finest shuttle woods from every aspect.

A tapered wooden rod called a " picking stick " moves the shuttle to and fro across the loom, American hickory being the traditional timber. Wartime difficulties of importation, however, focussed attention on the possibility of using densified compressed wood. This is made from numerous plies of veneers, each set at right-angles to the next, coated with synthetic glue and compressed to become a very strong dense and inert material. This product, marketed by three firms* in this country, met with success, and examples of textile machinery accessories already in use are shown in the illustrations above.

* See " Densified Wood ", Weekly Survey, page 619 in our issue of November 4.

The section of the loom known as the heald, which separates the thread to form the different patterns, is fitted on staves made of Canadian red pine or prime clear Western hemlock, the woven cloth moving on to another large roller of Douglas fir or occasionally obeche.

The woven cloth next finds its way to the inspection section where it is given a rigid examination for possible defects. The cloth is mounted on a wooden roller, and drawn from this over a smooth, birch-faced plywood table mounted on a frame of silver spruce.

Apart from home use, quantities of textile machinery are exported, and here again a considerable volume of the cheaper, lower grade timber is used to pack the looms and accessories, about 85 cub. ft. being needed to pack one loom.

PRESERVING TIMBER

Prevention of " Soft Rot " in Cooling Towers

The preservation of secondary or non-durable timbers has recently been enhanced by the introduction of a solution, " Tanalith C ", which has been found to give protection to timber for long periods, not only against " soft rot ", but also against the well-known fungi. Tanalith C, produced by Hickson's Timber Impregnation Company (G.B.) Limited, Castleford, Yorkshire, has been developed by the company as a specific answer to soft rot, which research has shown to be due to a fungus.

Soft rot is a recently diagnosed threat to timbers that was not recognised earlier because other forms of attack established themselves in the timber first. With the introduction of timber preservatives these primary forms of attack were held in check and it was then that soft rot made its appearance—particularly under conditions of heat and moisture such as are met in the tropics and, more familiarly, in cooling towers.

Its presence also remained concealed because no noticeable change in the appearance of the wood is produced, though when it is dry the wood is soft to the touch. The wood has, however, lost much of its mechanical strength due to the partial destruction of the secondary or outer cells of the timber; the heartwood is relatively unharmed. Such a condition is likely to be found everywhere since the damaging fungus is nearly ubiquitous, but, as already noted, development of soft rot is most pronounced in the presence of heat and moisture.

The answer to this form of attack has been found in the form of copper/arsenic salts efficiently applied to the timber in a water solution. Like earlier preservatives, Tanalith C is most effectively applied under pressure. The timber to be treated is put into a pressure cylinder and the air evacuated so that the cells of the timber are more easily accessible by the solution which is then pumped into the cylinder. It is to be noted that experience shows that no harm is done to the mechanical strength of timber by this process of evacuating the air and then forcing a solution into the cells. For conditions where attack is expected to be heavy, as much as four gallons of the solution may be forced into each cubic foot of wood.

The uses of this preservative are, of course, as wide as those of timber—in structural work as well as for such uses as poles carrying telephone wires or power cables. One considerable advantage of the solution compared with the familiar creosote is its property of not rendering the wood unpaintable.

Economically the new preservative is significant since it can make a lot of hitherto secondary timbers durable for constructional purposes. In particular, both Malaya and New Zealand have large tracts of forest from where the wood can now be rendered fit for use as railway sleepers, piling, power cable pylons and cooling towers. The general cost of the treatment is of the order of 12 per cent. of that of the untreated timber and an expected life of 20 years is claimed against this form of fungus attack. A number of timber merchants, both in the United Kingdom and overseas, are equipped to undertake the application of the preservative, but in all cases the plant is under the technical supervision of Messrs. Hickson, who developed and are the makers of the preservative.

POKE WELDER

Spot Welding in Inaccessible Areas

A poke welding device has been developed by the General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2, for use with their 4 kVA electronically-controlled spot-welding machine. Produced particularly for the aircraft industry, the poke welder facilitates the spot-welding of assemblies which are too large or too complicated to be accommodated in the machine, and allows reliable welding to be carried out when there is access to only one side of the metal.

The poke welding attachment has flexible cables with terminals at one end for connection to the welding machine. At the other end is a Paxolin cylinder carrying welding electrodes mounted side by side. In operation, the cylinder is held in one hand, the electrodes are pressed upon the metal to be welded, and the welds are initiated by a push-button switch. Two spot welds are effected simultaneously.

The performance of the poke welder has already been proved in the aircraft industry where it is employed in the fabrication of the sheet metal assemblies required for aircraft gas turbine engines. It is used to join stainless steel sheets 0·004 in. thick but has a wide range of potential applications, for example in the spot-welding of furnace linings, tubes, and canisters made from very thin sheets of ferrous or non-ferrous metals.

The success of the new poke welder is due to the cantilever method adopted for springing the electrodes and to the precision type of spot-welding machine with which it is used. This machine was developed for spot-welding very thin wires and sheets, particularly where dissimilar non-ferrous metals have to be joined. It supplies welding current in the form of heavy pulses of from $\frac{1}{2}$ to 6 cycles duration (0·01 to 0·12 second). The duration of the pulses is accurately timed electronically whilst a synchronising circuit ensures that welds always start at the same instant in a supply cycle so that the exact performance of the machine will be repeated. The fully variable controls have graduated scales to allow settings to be recorded.

The spot-welding machine has formed the basis of several developments of which the poke welder is the latest. Complete machines have previously been introduced for seam welding sheets, tubes and bellows, and diaphragms.

* * *

SECURITY SWITCH

Combination Lock Designed to Prevent Unauthorised Use

Primarily intended to prevent the theft or unauthorised use of motor vehicles, the Allo switch now being made by Brace Products, 10 Scutari-road, London, S.E.22, has many other similar uses. In fact it can be used as a safety switch for any machinery that requires the completion of an electrical circuit for its operation.

The " key " of the lock is an arbitrary combination of some of the eight letters marked on the dial. The pointer is rotated in an anti-clockwise direction and the centre knob depressed at each of the chosen letters. Depressing the knob operates a finger mounted behind the switch and thereby closes a contact. Rotating the knob clockwise releases all the fingers that have been engaged and so " locks " the switch. In a car, the contacts corresponding to the chosen letters would be wired in series with the ignition circuit, and the remaining contacts might be wired in parallel with the horn button. Thus to start the car it would be necessary to depress the knob at all the chosen letters, but depression at one of the others would sound the horn. Alternatively, the wiring could be arranged so that " wrong " operation blew the fuses.

The switch when mounted is totally enclosed so that the wiring cannot be traced; it can be mounted at any convenient point, on the dashboard, under a seat or under the bonnet. When in position, only the dial, pointer and central knob are visible. By suitable wiring it can be set so that lifting the bonnet, releasing the hand brake, depressing the clutch or changing gear will sound the horn. It can also be adapted to lock the doors of the car or be incorporated in the lock of a safe. If the combination becomes known, it can be changed by rotating the dial to a new position.

The poke welder is used in conjunction with a 4 kVA electronically-controlled spot-welding machine. Here it is seen in use on crimped stainless-steel sheet.

* * *

FREE PISTON GAS GENERATOR

A patent has recently been taken out (No. 737082) in the name of Mr. F. C. Perrott, senior gas turbine research engineer, W. H. Allen, Sons and Company Limited, Bedford, for the design of a free piston gas generator intended to increase the power output for a given size of generator. The invention includes both the cycle and the mechanism.

The cycle is single-stage compression in the Diesel cylinder combined with high-pressure bleed in the vicinity of the dead point. The bleeding precedes combustion, but may overlap it to some extent, and provides the turbo-drive. Initially it is proposed to retain a large excess of air in the cylinder.

The mechanism, as may be seen in the diagram, is a free-piston gas generator, with a large breathing capacity in proportion to its size and piston-speed. There are two combustion spaces between two co-axial pairs of opposed pistons, the centre pair being fixed back to back, and the outer pair tied together. The two assemblies are synchronised by a link mechanism to oscillate in phase so that compression takes place in one cylinder at the same time that expansion is occurring in the other.

It is expected that the mechanism will give substantially reduced loading for a given size, output and piston speed. Alternatively the loading could be increased to that of existing gas generators (for example, by supercharging) with a correspondingly increased power output. The basic cycle efficiency is slightly above that of the Diesel because the medium is expanded down to atmospheric pressure. It is hoped to publish details of trials on the prototype when these have been completed.

* * *

GAS FLOW RECORDER

For recording gas or air flow, an easily read instrument of simple construction has been introduced by Walker Crosweller and Company, Limited, Cheltenham.

Known as Arkon Recorder Model 1601, it is rectangular in shape and made of heavy-gauge sheet steel with a 6 in. chart ruled in straight lines. It is available either for wall or panel mounting. The visible length of the chart covers 16 hours and can be cut off daily, if desired, at any point of its travel, the free end being automatically gripped and wound on a roller which can hold as much as a week's record. The chart, which travels at $\frac{3}{4}$ in. per hour and lasts six weeks, provides a clear and permanent record.

The instrument is worked in conjunction with a differential pressure sensing element, usually an orifice plate installed in the gas stream. Impulse pipes from either side of the orifice transmit the variations in flow to a liquid sealed bell which is connected to a shaft rotating on ball bearings and moving a pair of cams which in turn transmit the impulses to the pen arm shaft. Equilibrium is restored by a change in the tension of a spring connected to the shaft. The complete mechanism has a low inertia and friction, and is sensitive to small changes in the flow rate. The bell and spring are of stainless material.

Where these recorders are used for process control the chart record is usually sufficient, but where they are required to show the total quantity of flow over a period an electrically-operated integrator may be optionally fitted. The index is visible through the recorder window above the chart mechanism. Operating on a 30 second cycle, the integrator adds up a series of spot readings and is therefore accurate despite fluctuations in rate of flow.

These new recorders have an interesting application for the metal industry, for example, as they clearly record the consumption of gas or gas/air ratio on aluminium billet and ingot pre-heaters, sheet furnaces, annealing furnaces, etc. They record the flow of gas to crucible furnaces for brass and lead and to rod mill furnaces for wire making. By the use of these instruments a careful check can be kept on all changes in the gas rate, automatic or manual.

* * *

FRICTION-GRIP CONVEYOR BELT

A new conveyor belt with a rough soft rubber surface for gripping smooth articles has recently been introduced by the Goodyear Tyre and Rubber Company, Limited. It has a top cover with a well-defined pattern moulded into it.

This deep pattern, combined with the comparative softness and the high co-efficient of friction of the rubber will prevent slipping on even quite steep inclines. (On conveyors handling sacks, packages and cartons on smooth belts the limiting angle is about 18 deg.) Sacks can be handled on a 30 deg. incline, the pattern intermeshing with the hessian to give a positive grip. Consequently, conveyors can be built with steeper angles to save floor space and, frequently, to simplify layout.

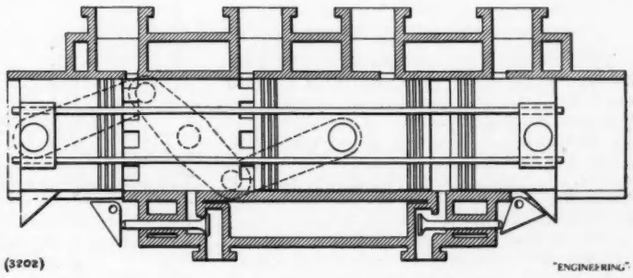
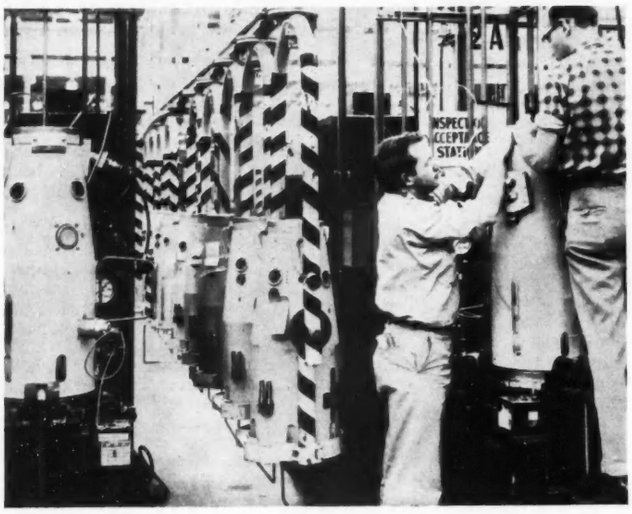


Diagram of proposed gas-generator. High-pressure bleed commences before combustion and supplies the turbo-drive.



Aft guidance sections of Convair-Navy Terrier guided missiles are given a final sectional examination at the Navy-owned plant in Pomona, California. The Terrier is the primary armament of the U.S.S. Boston, the Navy's first guided-missile carrier, which was commissioned on November 1.

U.S. NAVY'S GUIDED-MISSILE CARRIER COMMISSIONED

Convair Terrier Surface-to-Air Missile

On Tuesday, November 1, the United States Navy's first guided-missile carrier, the U.S.S. Boston, was commissioned at Philadelphia. The primary armament of the U.S.S. Boston is the Terrier surface-to-air missile, constructed by the Convair Division of General Dynamics Corporation at the Government-owned Naval Industrial Reserve Ordnance Plant, Pomona, California, which is operated for the navy by Convair. The above illustration, which is the first to be released, shows the aft guidance sections of the missile undergoing final checks before assembly at the Pomona works. On the right a section is seen on a vibration test rig.

Ground was broken at the 141 acre Pomona plant site in August, 1941, and limited operations were begun in the engineering building a year later. The finished plant—capable of complete missile design, manufacturing and testing, short of actual firing—was put into action in January, 1953. The manufacturing building covers 17 acres and includes more than half the 1,286,000 sq. ft. of floor space available at the entire Pomona facility. Because of the meticulous care required in making missiles, the entire plant is air-conditioned. Final assembly is done in a large dust-free room fitted with double doors.

The engineering building, which contains an analogue computer, a complete experimental factory and chemical and structural test laboratories, covers 384,000 sq. ft. It is flanked by several smaller structures that include two drop towers (one 200 ft. high), and two 34 ft. centrifuges, where missiles and components can be subjected to acceleration forces up to 60 times the force of gravity.

Other pre-production test equipment housed in the engineering area includes electro-magnetic and mechanical shakers that can vibrate specimens weighing from an ounce to a ton; a hot-cold room with a temperature range of minus 65 to plus 180 deg. F.; high temperature and altitude chambers, and a room screened against radio interference for checking guidance systems.

SOUND REPRODUCING AND MARINE RADAR EQUIPMENT

Display of Apparatus for Use at Sea and Ashore

A display of their Mimco sound reproducing equipment has been arranged by the Marconi International Marine Communication Company, Limited, at Marconi House, Strand, London, W.C.2. It comprises examples of all the apparatus required for this purpose both on board ship or ashore and includes a cabinet for controlling up to 60 loudspeakers. This contains an all-wave broadcast receiver, pre-amplifier, power amplifier and loudspeaker switching panel with a built-in monitoring loudspeaker. Any one of three independent microphone positions or the inputs from the broadcast receiver, a gramophone unit or tape player can be selected by a rotary switch and distributed to the loudspeakers.

COMMUNAL AERIAL SYSTEM

The Pantenna communal aerial system is also shown. This permits the independent use of as many as 80 receivers from a common aerial and thus avoids the employment of personal aerials on board ship, where they might undesirably affect the operation of the direction-finding system. It also enables programmes to be distributed to positions below decks, where it would be impracticable to erect aerials.

Two types of talk-back equipment—with three and ten positions respectively—are displayed. These enable orders and announcements to be passed from the bridge to, say, the engine room and answered by the personnel through a loudspeaker which also serves as a microphone, An electric alarm for fire and other purposes sounds either a variable frequency or fixed frequency siren and enables large motors to be dispensed with for this purpose. This alarm can be sounded over the loudspeaker network of a public address system.

The Marconi company's "Jericho" power megaphone and a number of microphones, loudspeakers, loud hailers and ancillary equipment are also on view. Finally, mention may be made of a display of tape-players and reproducers, which enable musical and other programmes to be broadcast when the use of disc records would be impossible owing to the weather. A selection of the necessary tapes can be borrowed from a "library" and exchanged after each voyage.

COMPACT RADAR EQUIPMENT

The "Quo-Vadis" radar equipment, which has been designed to provide more compact equipment than the firm's higher-power Radiolocator IV, was also on view. This consists of the display unit illustrated in Fig. 1 which has five viewing ranges covering radial distances of 0·6, 1·2, 3, 10 and 30 miles. The pulse lengths are switched automatically and extend from 0·1 microsecond on ranges of 3 miles or less to 1·0 microsecond above 3 miles, thus ensuring sharp definition at close range and sustained "hitting" power at longer distances.

The unit employs only 12 valves, including the cathode-ray tube. The latter gives a 6 in. display, and a detachable viewing hood with a built in magnifier brings this up to an effective 9 in. plant-position-indicator.

SCANNING AERIAL

A new type of off-set fed parabolic aerial which requires no de-icing equipment is used for scanning and is illustrated in Fig. 2. A fixed position performance monitor is fed from a small section of waveguide, which rotates with the scanner at 25 r.p.m. The peak power is 20 kW, which can be supplied from either alternating or direct-current systems. The operational controls include those for adjusting the tuning, gain, sea and rain clutter, brilliance, bearing scale illumination, bearing cursor rotation and range rings. The heading marker and performance indicator can be switched on or off and an expanded centre device operates on the 0·6 mile and 1·2 mile ranges.

The Quo Vadis is now being fitted on a number of liners, including the Himalaya, Orcades and Chusan, and as a secondary radar system.

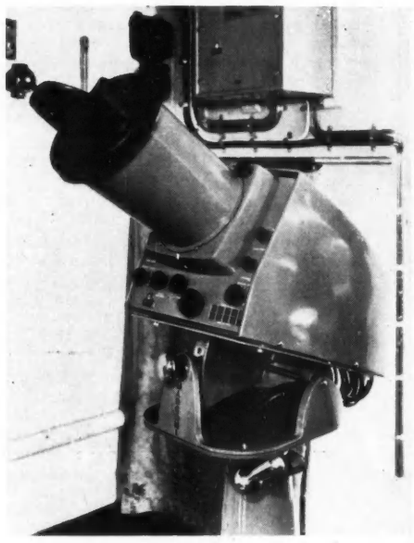


Fig. 1 Display unit of Marconi "Quo Vadis" marine radar equipment on its pedestal mounting.

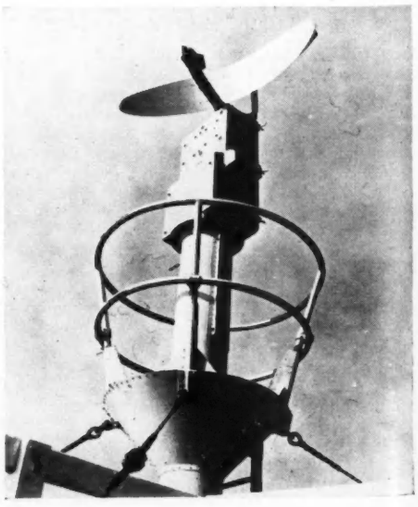
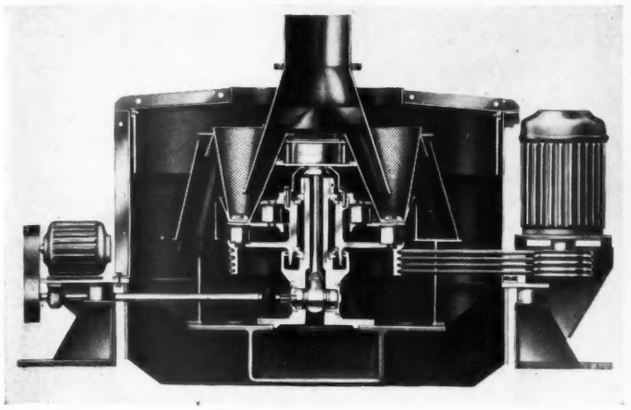
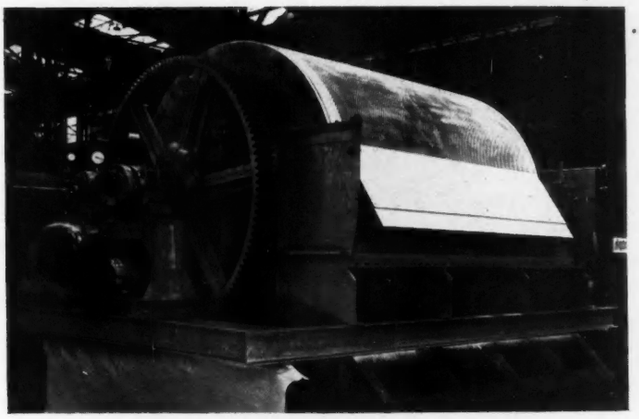


Fig. 2 The aerial scanner of the "Quo Vadis" radar set requires no de-icing equipment.



Axial vibration is superimposed on the rotating screen of the Humboldt centrifugal de-waterer. It results in continuous discharge without mechanical aid and a high yield of solids.



The Humboldt rotary suction filter is non-cellular in construction, 95 per cent. of the drum area being under vacuum. Cake-stripping is by means of a small stationary pressure chamber.

DE-WATERING AND FILTERING

Plant for Mines and Chemical Works

Among the new products introduced by Klöckner-Humboldt-Deutz A G., Cologne, Germany, are two items, illustrated above, having particular applications in the mining, mineral-dressing and chemical industries.

The Humboldt continuous-discharge centrifugal de-waterer for small coal and other materials has axial vibration superimposed on the rotating screen-drum. This results in a reduction of friction between the wall of the screen and the feed material as well as in the body of the material itself, and a constant rate of discharge is maintained without the need for any mechanical device. The solids form a uniform layer over the screen-surface, the thickness of the layer being controllable as desired. This layer is kept in constant motion, so that its movement resembles that of a liquid, and as it is alternately compressed and loosened, the separation of the water is greatly facilitated. The compact layer of material acts as a natural filter, and the result is a very high yield of solids, which remains practically constant during the life of the screen. A low speed of rotation and the low contact-pressure between the material and the screen lead to long screen-life. Reduction of grain-size in the product is almost entirely eliminated.

Typical operating results, when treating small coal 0 to 10 mm. in size are: surface moisture of product 5 to 7 per cent.; yield of solids up to 98 per cent.; throughout up to 100 tons per hour, with a power consumption of less than 0·2 kWh per ton. The screens have a service life of up to 40,000 tons under these conditions.

SUCTION FILTERING

In the Humboldt non-cellular filter the complete drum is under vacuum, and the stripping of the filter cake and flushing of the filtering medium are effected from a comparatively small pressure chamber extending over the full length of the drum. This chamber is sealed from the vacuum in the drum by means of a heavy rubber frame held in uniform contact with the inner side of the drum wall. The drum rotates on a stationary hollow axle, which carries the pressure chamber by means of a bracket assembly. The necessary pipes for vacuum, compressed air and flushing liquid are also carried by the hollow axle.

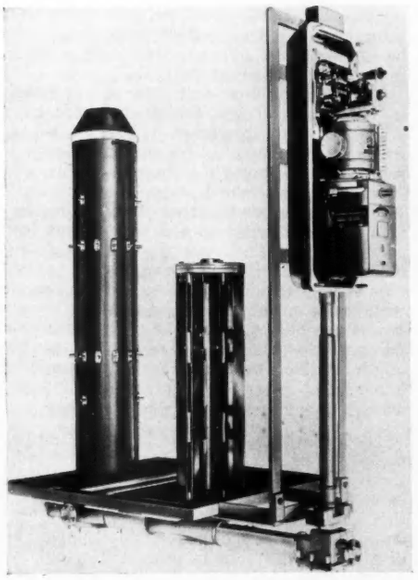
The absence of cells means that there are no dead spaces to be re-evacuated repeatedly, and the vacuum area extends over about 95 per cent. of the drum. This gives a large effective filtering and drying area. Relatively small air-pumps can be employed, and the power consumption, as a result, is low.

ON-LOAD TRANSFORMER TAP-CHANGER

The on-load tap changing gear shown in the accompanying illustration is shortly to be installed on a number of 5 MVA, 33 kV transformers, which are being manufactured for an Area Electricity Board by Transformers (Watford), Limited, Watford, Hertfordshire.

This equipment, which has been designed by Dr. A. Jansen and is made by Maschinenfabrik Rainhausen, Regensburg, Germany, is of a type which has been in use on the Continent for many years. It permits operation over 16 steps and as it is installed in the main transformer tank near the windings its overall dimensions are kept small. The current-breaking diverter switches, together with their operating mechanism, are contained in a separate compartment under oil.

Maintenance of the diverter switches is facilitated by a valve which enables fouled oil to be drained from the tank while the transformer is on load, replenishment being effected from the conservator. When it is necessary to inspect the on-load switch it can, as shown on the right of the illustration, be withdrawn through the top of its cylinder without disturbing the transformer connections, or gaskets, drawing off oil or opening the tank. The switch with its operating mechanism is connected to the transformer through plugs, while the equipment is protected against arcing by an oil relay.



On-load tap-changing gear for 5 MVA, 33 kV delta-star transformer.

The operating mechanism is driven by equipment housed in a weatherproof cubicle on the side of the transformer tank. This cubicle contains the driving motor, re-setting relay, contactors, local tap-position indicator, etc.

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STRUCTURAL STEELWORK

A Firm that has Grown with It

The celebration recently by John Booth and Sons (Bolton), Limited, of the 50th anniversary of the opening of their Hulton Works at Bolton was a reminder of the increasing application of steel to building and structural work. The firm had, in fact, been engaged in steel fabrication before the end of the last century—at a works in Marsden-road, where Samuel Crompton, the inventor of the spinning mule, began spinning cotton as a commercial project. John Booth, the founder, had started in 1873 as an "engine and machine smith." He did builders' smith-work, and then turned to steel fireproof doors, and steel and glass partitions. In due course, moving with the times, he turned to steel roof trusses and then to complete steel-framed buildings. With the expansion of business, the Hulton Works was established in 1905. Before the first World War oxy-acetylene welding was introduced by John Booth's eldest son, James, and during the war a start was made with electric welding. It was applied at an early date to the construction of storage tanks for petrol stations, and later to structural steelwork, though it was not until the late 1930's that electric welding was generally and officially approved for this type of work. To-day a great variety of steelwork is turned out at the 50-year old factory.

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LUBRICATION ON SITE

As a means of lubricating heavy equipment working on remote sites, John B. Pillin, Limited, of West Hartlepool, have built a mobile lubrication unit. It consists of a Foden chassis on which is mounted a specially designed body housing an air compressor driven from a power take-off, four lubricating-oil storage tanks, two 1 cwt. grease barrels, a pressure water tank, and eight Wakefield hose reel units.

The vehicle was ordered from C. C. Wakefield and Company, Limited, by the International Construction Company, Limited, on behalf of the Steel Company of Wales, at whose Abbey Works the unit is operating. It is being used to lubricate a fleet of metal-recovery machines owned by Heckett (Wales), Limited, who are engaged on a slag disposal scheme at the Works.

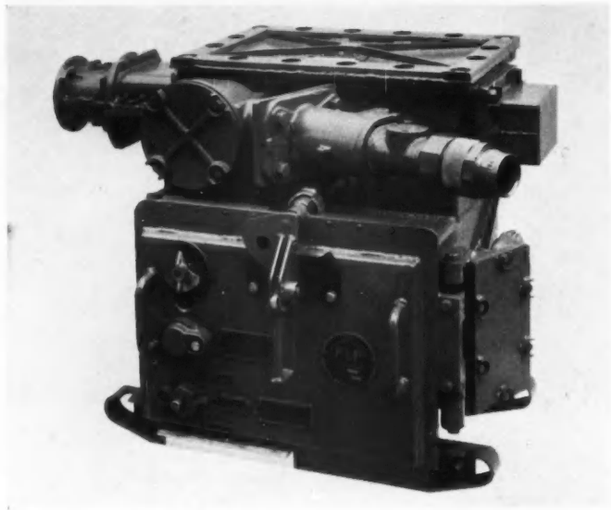

Fig. 1 Automatic flameproof gate-end panel which has been designed for use with motors operating plant at the coal face.

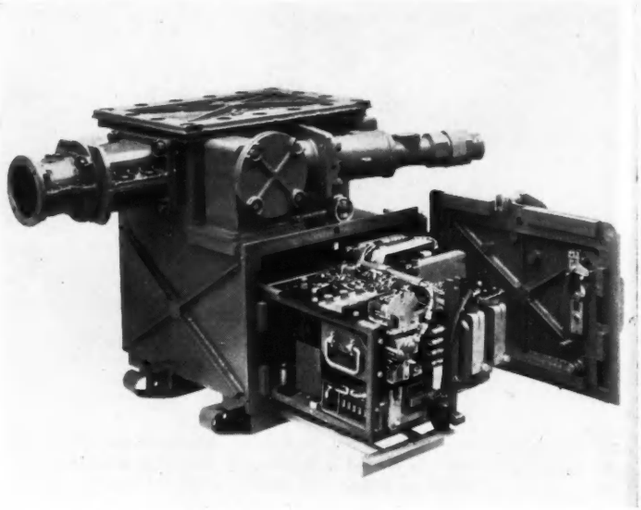

Fig. 2 View of the panel with front cover open and chassis withdrawn on its retractable support.

FLAMEPROOF GATE-END PANEL

GENERAL PURPOSE CONTROL SWITCH FOR MINES

An automatic gate-end panel, the dimensions of which comply with the National Coal Board's Specification No. P3/1950, has been produced by the General Electric Company, Limited, Kingsway, London, W.C.2, and is illustrated in Fig. 1. It is primarily intended for controlling motors driving coal-cutters, loaders and conveyors at the coal face and is designed for full load currents up to 80 amperes at 400 to 600 volts. Being flameproof it is suitable for use in fiery mines, while the control and earth leakage electrical lock-out circuits are both intrinsically safe.

GENERAL DESIGN

The panel consists of a skid-mounted case of mild steel sheet, which is divided horizontally into two compartments. The upper portion is provided with a heavily-braced top, while the lower is fitted with a hinged front cover which, when closed, is secured by locking dogs. The front cover is provided with a single socket-headed fixing screw, so that it can only be opened by an authorised person. This screw also forms an interlock with the isolator, as it cannot be unscrewed unless the latter is in the "off" position. In addition, when the door is closed the screw must be driven home before the isolator can be closed.

The top compartment houses the 300-ampere busbars and a triple pole reversing isolator of the contactor type, which is fitted with series blow-outs and arc chutes and is designed to break 650 amperes at 650 volts at a power factor of 0·2 to 0·3. It has an auxiliary contact which is connected in series with the operating coil of the contactor, and is arranged to open before the main contacts. The operating lever is brought out to the front of the unit, and carries a catch which engages with a gate on the front cover. As a result the isolator cannot be moved from the "forward" to the "reverse" position without a pause. It can also be locked in the "off" position by a shrouded captive screw. A flange at each end of the compartment carries three main and two auxiliary bushed terminals, by means of which connections can be made to the incoming terminals or adjacent panels.

WITHDRAWABLE CHASSIS

As shown in Fig. 2, the lower compartment houses a withdrawable chassis on which the triple-pole main contactor, two overcurrent relays, the core-balance and voltage transformers and the protective relays and fuses are all mounted. The chassis also carries a combined test and re-set switch, a local control switch and a sequence selector switch with an emergency stop button. A lamp for indicating earth leakage faults is visible through a window in the cover. The rating of the main contactor is the same as that of the isolator, and both it and the relays are designed to operate satisfactorily at a maximum inclination of 15 deg. to the vertical in any direction.

The main and auxiliary isolating contacts engage with spring-loaded contacts on the underside of the horizontal partition. These contacts complete the connections from the equipment on the chassis to the isolator and thence to the incoming supply and the outgoing cable through an external plug-and-socket. A chassis can therefore be removed and a spare substituted without disconnecting any leads. In the working position the chassis is secured by a single screw, while when withdrawn, as shown in Fig. 2, it can be supported on a framework which, when not in use, is housed under the case.

The incoming three-core cable can be coupled to either end of the busbar chamber by an adaptor of the type shown in Fig. 2. When a five-core trailing cable is used to supply the motor it is coupled to the panel through a 100-ampere restrained type plug-and-socket. This is mounted on the front of unit by means of an adaptor attached to the step on the lower compartment. The connections are so arranged that it is impossible for open sparking to occur, even if an attempt is made to remove the plug with power on the cable. An auxiliary terminal box is mounted on the right of the lower compartment for the reception of the twin-core control cables necessary for sequence interlocking.

INTRINSICALLY-SAFE CONTROL

The intrinsically-safe control circuit is normally completed by a pull-push remote control switch through the pilot and earth cores of the trailing cable to the motor. This circuit is arranged so that if a fault occurs between the pilot and earth cores in the cable the main contactor opens and disconnects the motor from the supply. A switch is provided so that this fault can be simulated for test purposes. A local control switch is mounted in the panel and the change-over from remote to local control or vice versa is effected by a selector switch.

The earth leakage protection circuit, which is energised through a core-balance transformer, is designed so that the control relay locks out as soon as it has operated on an earth fault. Once the fault has been cleared the relay may be re-set to the running position by a switch which is only accessible to authorised persons. The motor cannot be started if an earth fault of a resistance higher than that which would cause tripping during normal running is already on the system.

Selective tripping can be arranged by connecting a resistor in the protection circuit. This enables the tripping current to be varied from 1 to 2·5 amperes, the corresponding resistance of earth faults for which the lock-out circuit will function being from 5,000 to 450 ohms. A test switch is provided for checking the functioning of the earth leakage protection system.

A split adaptor is fitted between the busbar chambers of two or more panels which it is required to couple together, while the units are also joined together at the base by a plate which bolts on to the skids.

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SHORT-RANGE RADIOTELEPHONE

Choice of Eight Frequencies

Mullard and Company, Limited, Century House, Shaftesbury-avenue, London, W.C.2, have designed a short range transmitter-receiver for radiotelephony with a range of 1·5 to 12·5 megacycles; facilities for telegraphy are also provided. The apparatus is intended for use by postal and telegraph authorities and the police, but can also be employed on civil engineering projects and for defence.

The equipment can be operated from either an alternating or direct-current supply at a number of different voltages, and eight crystal-controlled frequencies are available for transmission. The tuning is pre-set for each channel and the circuits are ganged to the crystal selector switch so that no tuning is necessary when changing the frequency. The receiver is continuously tunable over the same range as the transmitter and control has been greatly simplified.

The transmitter, receiver and power unit are contained in a cabinet measuring 20 in. by 14½ in. by 7 in. and all the chassis are mounted on the rear of the hinged front panel so that servicing is facilitated. Shock absorbers are provided for vehicle mounting.

BRITISH CIVIL AND MILITARY AIRCRAFT

MINISTRY OF SUPPLY'S REVIEW

At a Press conference recently, the Ministry of Supply summarised the present position of the British aircraft industry. During the last five years there has been a great expansion of production, which has now reached a peak but is expected to tail off somewhat during the next few years. The Ministry admit that, although British designers are capable of producing brilliant ideas, there is some difficulty, with our rather modest technical manpower resources, in developing them to the state where they can be produced. In future, the Ministry hope to avoid the mistake of trying to spread these resources over too wide a field.

A particularly disappointing failure in development is the Vickers V.1000 military transport aircraft which was envisaged with the idea that a civil transport could be developed from it. This aircraft would have introduced the promising Rolls-Royce Conway bypass engine to transport service. The Air Ministry performance specification, however, was a stringent one, and it has proved to be impossible to fulfil it in time to meet Transport Command's urgent needs. The Ministry have therefore cancelled the orders for the six aircraft for the Royal Air Force, which instead will now be equipped with six long-range Britannia Mach 250LR aircraft in addition to the three already on order. Since British Overseas Airways Corporation have no requirement for the V.1000—they already have Comet 4's, Britannias and D.C.7c's on order which will satisfy their needs until well into the 1960's—the Ministry will not support the development of a civil version. To ensure the development of the Conway engine, the Ministry are considering installing it in the V bombers; but it is unfortunate that the Conway engine, so promising in its civil applications, cannot undergo development for commercial use in a British airliner, in the same way as its brothers the Dart and the Tyne.

The Britannia airliner, on the other hand, is making good progress and collecting orders, and it is expected that the long-range version will be ready for non-stop transatlantic services with full payload in 1958–59. Before this time, however, the D.C.7C airliner is expected to be in operation non-stop between London and New York. The Ministry cite the comfort and silence of the turbo-propeller aircraft as two of its principal virtues. Its most important virtue, and the one which merits overseas orders, is perhaps economy in operation.

COMET 4

The Ministry state that the Comet 4 is progressing well, but has a tight schedule to conform to; and its success depends crucially on realising its promised delivery date to B.O.A.C.—1959-60. Since it is the de Havilland company that is concerned—they have always shown themselves aware of the importance of keeping to schedule—there is a good prospect that the target may be reached.

On the military side, the Ministry professed themselves satisfied that the Hunter is as good an aircraft as any in the western hemisphere for its purpose of bringing down enemy bombers; although not as fast as some American machines, its heavy armament and manoeuvrability are advantageous. The Hunter will be followed by the P.1, which is developing well and is regularly exceeding Mach 1 on climb.

Two new fighter projects were disclosed, with mixed jet and rocket power plants—the Avro 720 and the Saro SR53. The latter aircraft has been selected by the Ministry for further development. Mention was also made of a vertical take-off project, the P.D.11, by Short Brothers and Harland, Limited.

The Javelin all-weather interceptor has now overcome its development troubles, and has practically reached the state where it can be released for squadron service. As regards bombers, production of the Valiant, now in service, will soon begin to tail off, and ultimately will be replaced by the Vulcan, progressing very favourably, and later the Victor, the development of which is less advanced than that of the Vulcan, but is considered by the Ministry to be satisfactory.

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THE BEAMA DINNER

Optimism in the Electrical Industry

A dinner of the British Electrical and Allied Manufacturers' Association was held at Grosvenor House, London, W.1, on Wednesday, November 16, the President (the Rt. Hon. Viscount Chandos, D.S.O., M.C.) being in the chair.

Proposing the toast of "Our Guests," Mr. E. H. Ball, chairman of the Council, said that the electrical industry—which Ministers viewed with awe and also with a little bewilderment—was the bulwark of our economy. Among other properties it offered great scope for improving human relationships, without which we could not hope to survive. He therefore pleaded that no opportunity should be lost to make more friends and that indeed was one of Beama's functions.

In reply, the Hon. Sir Thomas White, High Commissioner for Australia, paid a tribute to the work of the Association in extending the prestige of the electrical industry throughout the world. There was need for reciprocation of a high order between Great Britain and the Dominions, in order that the strength of both should be increased.

In proposing the toast of "The Electrical Industry" the Rt. Hon. A. R. W. Low, Minister of State, the Board of Trade, pointed out that several reasons had been given why foreign competitors were gaining a larger share in an expanding world market. One of these was that the credit insurance facilities offered by the Export Credits Guarantee Department were not so good as those available in foreign countries. He could find no evidence to support this view. Another reason was that some countries operated export subsidies. As far as Germany was concerned, these would cease at the end of the present year; and the British Government was using all means open to them to encourage other countries to abandon such practices. A third reason was that the industry was overloaded, but attempts were being made to deal with this; while a fourth was that our costs were higher than those of our competitors. Information about new contracts, however, was proof of our competitiveness. Nevertheless, complacency could not be afforded and to avoid this was the responsibility not only of both sides of industry, but of the Government. It was a major aim of the latter's economic measures to encourage efficiency and to keep industrial costs down.

In reply, the President said that the electrical industry had to prophesy where it was going between now and the end of the century and what were its prospects. Upon the success of this estimation many things would depend especially in the fields of direction and policy. Otherwise no number of loyal and hardworking workpeople would correct the mistakes that would be made.

During the next decade the consumption of electrical energy would double and the demand was especially likely to increase in the fields of mechanisation, traction, electronics and "nucleonics." The present shortage of man-power meant that people must only be used where intelligence was required, and electronics was making it possible for the lowest forms even of intelligent work to be carried out by the electric motor. There would be an increasing demand for electric traction, and discoveries in semiconductors and transistors opened up great possibilities in radio and radar. In fact, to use one of the gardening metaphors which were so dear to the heart of the Chancellor of the Exchequer, we could see these plants, some of which had hardly emerged from the hot-houses of research and development, spreading out into the gardens or fields of the whole country and bringing to mankind a new power to create wealth.

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LAUNCHES AND TRIAL TRIPS

S.S. "VIBEX."—Single-screw oil tanker, with accommodation for a small number of passengers, built and engined by Harland and Wolff, Ltd., Belfast, for Shell Tankers, Ltd. (Marine Managers for the Anglo-Saxon Petroleum Co., Ltd.), London, E.C.3. Main dimensions: 635 ft. between perpendiculars by 84 ft. 3 in. by 46 ft. 3 in. to upper deck; deadweight capacity, about 31,500 tons. Double-reduction geared steam turbines, developing 13,000 s.h.p. at 105 r.p.m. in service. Steam supplied by two water-tube oil-burning boilers, constructed by the shipbuilders. Delivered, October 21.

S.S. "CYDONIA."—Single-screw cargo vessel, built and engined by John Readhead & Sons, Ltd., South Shields, for the Stag Line Ltd., North Shields. Main dimensions: 405 ft. between perpendiculars by 56 ft. 9 in. by 32 ft. to upper deck; deadweight capacity, about 8,150 tons on a draught of 24 ft. 1 in. Triple-expansion steam reciprocating engine working in conjunction with a Bauer-Wach low-pressure exhaust turbine. Steam supplied by three oil-fired boilers. Service speed, 12 knots. Trial trip, October 25.

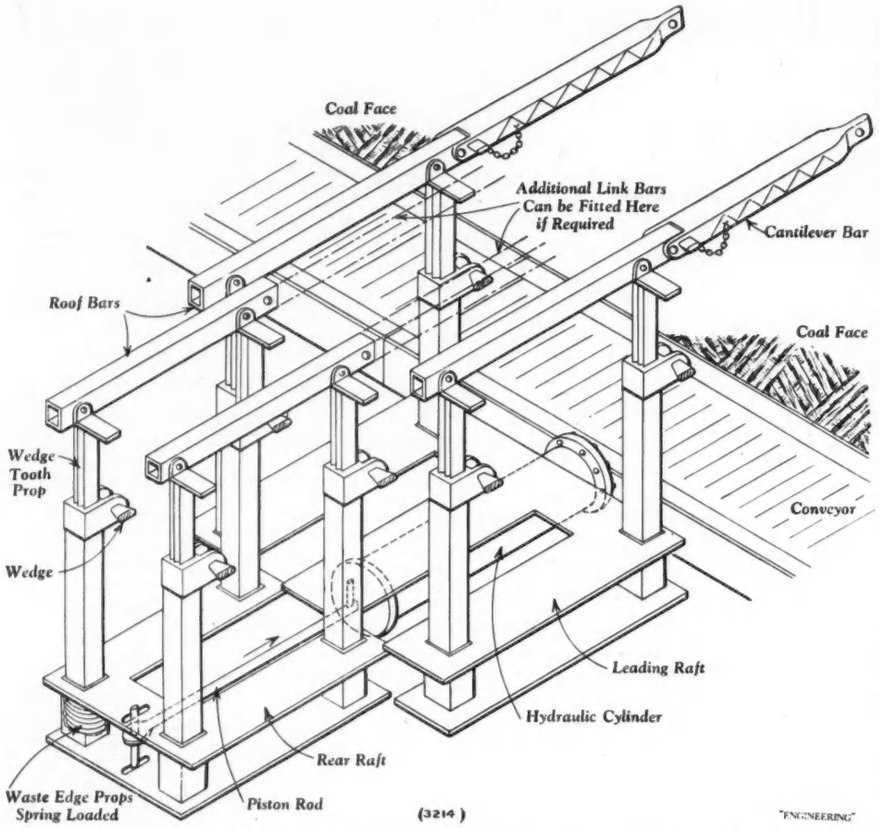
M.S. "PORTSLADE."—Single-screw collier, built by Austin and Pickersgill, Ltd., Sunderland, for Stephenson Clarke, Ltd., London, E.C.3. Main dimensions: 231 ft. by 40 ft. 2 in. by 17 ft. 10½ in. to upper deck; deadweight capacity, about 2,360 tons on a mean summer draught of 17 ft. 1 in. Clark-Sulzer eight-cylinder single-acting two-stroke trunk-piston oil engine, constructed by George Clark and North Eastern Marine (Sunderland) Ltd., Sunderland. Service speed, 11 knots. Trial trip, October 26.

H.M.C.S. "ST. LAURENT."—Twin-screw anti-submarine destroyer, built by Canadian-Vickers, Ltd., Montreal, for the Royal Canadian Navy. The vessel is the first of a number of ships of this type, is 366 ft. in length, 42 ft. in breadth and has a displacement of 2,600 tons. The machinery, comprising steam turbines, water-tube boilers and auxiliary equipment, all of advanced design, was supplied by Yarrow & Co., Ltd., Scotstoun, Glasgow, and shipped to Canada. Commissioned, October 29.

M.S. "ESPEN."—Single-screw cargo vessel, built by Short Brothers, Ltd., Sunderland, for Mr. Bj. Ruud-Pedersen, Oslo, Norway. Main dimensions: 450 ft. between perpendiculars by 61 ft. by 38 ft. 8 in. to shelter deck; deadweight capacity, about 10,200 tons on a mean summer draught of 26 ft. 7½ in. Kincaid-Harland and Wolff-Burmeister and Wain five-cylinder single-acting two-stroke Diesel engine, developing 5,500 b.h.p. at 110 r.p.m. Engine arranged to burn heavy oil. Service speed, 14 knots. Trial trip, October 31.

M.S. "REDCAR."—Single-screw ore-carrying vessel, built by Smith's Dock Co., Ltd., South Bank-on-Tees, for the North Yorkshire Shipping Co., Ltd., London, E.C.3. First of two vessels of this type for these owners. Main dimensions: 480 ft. between perpendiculars by 68 ft. 9 in. by 36 ft. 3 in. to upper deck; deadweight capacity, about 15,200 tons on a draught of 28 ft. 11 in. Hawthorn-Doxford four-cylinder two-stroke opposed-piston Diesel engine developing 4,450 b.h.p. at 115 r.p.m. in service, constructed by Hawthorn Leslie (Engineers), Ltd., Newcastle-upon-Tyne. Service speed, 11½ knots. Launch, October 31.

H.M.S. "EXMOUTH."—Anti-submarine frigate, built by J. Samuel White & Co., Ltd., Cowes, Isle of Wight, for the Admiralty, London, S.W.1. Length 310 ft. overall and beam 33 ft. Aramament comprises three Bofors guns and two three-barrelled anti-submarine mortars. Propulsion provided by geared steam turbines constructed by the shipbuilders. Launch, November 16.



The Ritchie roof support is shown in the extended position; the rear raft is subsequently drawn "into" the leading raft by means of the piston. After removal of the coal from the face, the leading raft is hydraulically extended to the position shown, thus completing the cycle.

SUPPORTING THE ROOF OF AN ADVANCING COAL FACE

A SYSTEM ADAPTABLE TO EXISTING EQUIPMENT

Numerous proposals for giving continuous support to the advancing roof of a coal face have been made, and patents have been granted in this country and overseas for a variety of devices designed for this purpose. The essential features of an effective roof-support system are: the roof must be continuously supported; the support-density and load-bearing capacity must be adequate for the particular installation; the supports must have a high setting-load and a high initial resistance to yielding and must be safe and easy to withdraw, move and re-set.

To meet these requirements, with the maximum degree of simplicity and economy in manpower, Mr. Campbell Ritchie, Bisley House, Kensworth, Bedfordshire, has developed the movable support system illustrated above. It supports the roof continuously, even when the individual units are being moved forward, the manpower requirements are small, and it is free from components which are liable to breakdown or damage. It can be adapted to suit existing telescopic pit-props and roof-bars.

The Ritchie movable support system consists of five elements, floor raft, moving device, pit-props, roof-bars, and lifting device. The floor raft is formed of two fabricated steel units, one of which is guided within the other. Reinforced apertures are provided at certain points in the rafts to allow the pit-props to pass through and stand on the floor. Springs are fitted to lift the goaf-end props out of the ground when the floor is soft; all the apertures can be so equipped if the nature of the floor makes it necessary.

A compressed-air or hydraulic cylinder provides the motive power for traversing the supports. The body of the cylinder is attached to the leading floor raft, and a cross-head on the end of the piston rod is connected to a movable pin at the goaf end of the rear floor raft. Retraction of the piston and rod therefore draws the rear raft with its props along guides into the leading raft. The pit-props can be of any telescopic type provided that they have some means of prestressing the prop to 10/12 tons immediately it is set, and that there are means of attaching the roof-bar to the head of the prop. With complete installations Ritchie Lamella props, or Ritchie wedge-tooth props, as shown in the illustration, are supplied. The roof-bars can be of any type, so long as they are of a shape which permits them to be attached to the prop-heads. The type of roof-bar usually supplied is a simple box-section, with a small number of link-bars for fitting at the face-end. Independent power-lifting devices are provided so that the props can be set quickly.

A typical layout is shown in the illustration. Four apertures are provided in both the leading raft *a* and the rear raft *b*. The number of props per unit may be reduced where local conditions permit. The apertures extend right through the rafts, and the props rest on the mine floor. As the props have a high yielding resistance, some floor penetration may take place, and springs are provided in the goaf prop apertures for lifting the props when they are released. When the floor is very soft all the apertures may be provided with springs.

At the beginning of the coal-winning cycle the supports are in the contracted position, with the roof supported up to the face by the link roof-bars and the first row of props immediately behind the conveyor. When the coal has been stripped-off, the conveyor is snaked forward, and the props in the leading raft are released. This raft, with its props and bars, is then advanced by the pushing cylinder, the rear raft remaining in position with its props and bars under pressure from the roof. Normally the props and bars in the rear raft, in conjunction with the adjacent rafts, suffice to support the roof safely, but if desired an additional pair of link-bars can be fitted to the ends of the bars in the rear raft.

When the supports are in position, the rear rafts are ready for movement. The pushing cylinder is then reversed, and the rear rafts are drawn into the spaces in leading rafts. It is an advantage to allow an interval in the cycle between the movement of the rafts. This allows the props in the leading rafts to take up a higher load where this is provided by roof pressure.

★ ★ ★

PORTABLE CATHODE-RAY ENGINE INDICATOR

An addition to the range of electronic indicating equipment for internal-combustion engines that is being made by Southern Instruments, Limited, Camberley, Surrey, is a portable set, the M 986, the power supplies for which are derived from a rotary transformer driven by a 12 volt accumulator. The set measures 14 in. by 11 in. by 12 in. deep and weighs 40 lb. It is intended for making qualitative tests in the field.

The instrument incorporates a 2·75 in. (70 mm.) diameter cathode-ray tube with a cylindrical telescopic light shield for use under conditions of high ambient light. A two-stage direct-coupled Y-amplifier gives a maximum sensitivity of approximately 0·23 mm. per mV. An additional stage provides electrical differentiation or integration when required. The repetition rate of the linear time-base may be varied from 5 to 5,000 c/s and can be free-running or self-synchronised to the Y-axis signal over a very wide frequency range without manual adjustment. This enables a steady picture to be displayed even while an engine is accelerating. A marker amplifier allows time or crank-angle degree marks to be superimposed on any signal.

Two types of pre-amplifier are included; one is an a.c. amplifier for use with resistance gauges or self-generating pick-ups and the other is a phase-modulated circuit for use with variable capacitance or inductance transducers. Provision is made for energising electrical resistance strain gauges or variable-resistance transducers from a small internal dry battery. The pre-amplifiers can be set up with their respective transducers and switched into circuit as required.

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1,000 WATT INFRA-RED LAMP

Quartz Envelope Used

A 1,000 watt infra-red lamp has been developed for industrial purposes by Philips Electrical, Limited, Shaftesbury-avenue, London, W.C.2, to provide higher radiation intensities than a 250 watt lamp.

It is of tubular design and, owing to the thermal strains to which glass would be subjected, has a quartz envelope, the diameter of which is only 10 mm. The filament is about 290 mm. long so that the power consumption is in the region of 35 watts per cm or about three times that of the 250 watt lamp. This renders the new lamp suitable for applications where a high temperature and great concentration of energy are required. The small dimensions of the tube also simplify installation.

The life is about 5,000 hours and, due to the use of quartz, wave lengths longer than 7 microns can be transmitted, compared with 5 microns for the glass normally used in incandescent lamps. The colour temperature of the filament is about 2,200 deg. K.

AUTOMATIC ELECTRIC CONTROL GEAR

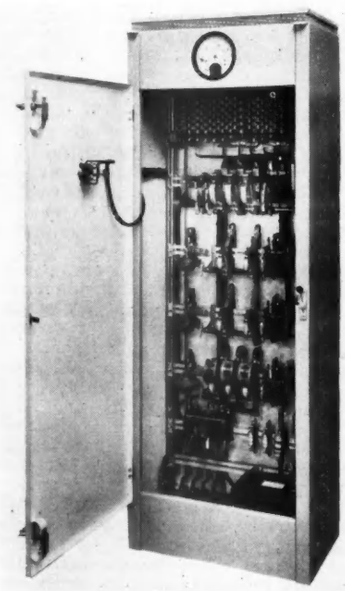
ASSEMBLY ON THE "MECCANO" PRINCIPLE

An outstanding feature of a new range of control gear which has been introduced by the Electric Construction Company, Limited, Bushbury Engineering Works, Wolverhampton, is the use of the "Meccano" principle to facilitate both erection and replacement on the consumer's premises. It also enables stocks of spares to be reduced.

The various units of the gear, which is being made in ratings up to 750 amperes alternating current and 1,000 amperes direct-current, are built up on a metal framework to which cross-members are bolted. These members carry the fixed contact assemblies and contactor coils as well as the arms which hold the rotating bars on which the moving contacts are mounted. Both the cross-members and the fixing arrangements are identical whatever the capacity of the contactors.

In a typical equipment, for instance, the contact assembly is mounted on steel bars of square section which are partially insulated by Bakelite, the cylindrical ends being carried in bearings and the armature of the coil being clamped on the uninsulated portions. The moving contacts of the main contactor and its auxiliary switch are assembled in a similar manner, and the mouldings have recesses cut in them to ensure that the unit cannot turn. The completed moving coil assembly is then fixed to the frame by inserting each end in an arm which is bolted to the cross-member. The fixed contact assembly and the fixed section of the coil magnetic circuit are also bolted to the cross-member, the arrangement being such that the alignment is automatic. The coil is held in position by two spring clips which bear on the end cheeks, and a quick-acting release, consisting of a bayonet fixing, enables the whole of the moving assembly to be lowered for access.

One of the advantages claimed for the new construction is that the dust does not collect on the vertical surfaces of the mouldings. Extra contacts can also easily be added by using a longer shaft. The auxiliary contacts have solid silver tips and the operating magnet has a self-aligning armature with leaf-spring damping.



Stator and rotor control cubicle for slip-ring motors, the equipment in which has been built up on the "Meccano" principle.

A quick-acting trigger release is provided for opening up the magnet so that its contacts and pole faces can be inspected, while the coil is held in position by springs which, besides enabling it also to be quickly dismantled, prevent movement under vibration.

A range of ancillary fittings, including isolators for interlocking with the cubicle doors, mountings for high rupturing capacity fuses and magnetic overload trips of the dash pot type, are available. A sealed pneumatic timing device of the diaphragm pattern, which can be arranged for delays from 0·5 seconds to 30 seconds, can also be supplied, thus covering all starting characteristics. All these accessories are designed so that they can be fixed to uninsulated bars by a single bolt in the same way as the contactors.

While normally the contact assemblies are built up into complete units, separate poles and auxiliary switches can be supplied, thus enabling any required combination to be obtained to suit individual requirements.

A stator and rotor cubicle for control of slip-ring motors which has been constructed on the principles described is illustrated below.

* * *

RADIO-RELAY SYSTEMS

Multi-Channel Problems

In the course of the Chairman's address, which he delivered to the Radio and Telecommunication Section of the Institution of Electrical Engineers on Wednesday, October 19, Mr. H. Stanesby described how radio-relay systems were used for television and multi-channel telephony and dealt with the steps that had been taken to associate them with line systems at home and abroad.

The modulation of the carrier with speech, its removal and the selection of one side-band by using a balanced modulator and filter led to the development of carrier systems in which the speech side-bands were placed side by side in the frequency spectrum, thus enabling a number of telephone channels to be provided over the same pair of conductors. The system, which was known as the frequency division multiplex (f.d.m.), had been developed to provide up to 60 channels per pair over cables containing 24 or more balanced pairs at frequencies of 3,000 kilocycles or more; and several hundred channels per pair over specially designed cables containing several coaxial pairs.

The three principal problems in connection with such a system were the assembly and separation of the channels at the two ends; the interconnection of similar and dissimilar systems; and the avoidance of interference between the channels. To deal with the first, processes demanding high selectivity were carried out at fixed frequencies and the signals were translated to transmission frequencies by another operation. Interconnection was best effected by transferring channels in groups, or as a whole, without frequency translation, while interference and noise due to intermodulation could be reduced by using highly linear negative feed-back amplifiers in the main transmission path; or by confining frequency translation processes to blocks of channels lying within a two to one frequency ratio and translating at low signal levels.

Contemporary development might be said to have sprung from the spectacular advances which had occurred since 1940 in the frequency ranges of 300 to 3,000 and 3,000 to 30,000 megacycles. These permitted the employment of broad-band systems with highly directional aerials and the free propagation of signals over line-of-sight paths. The higher the frequency the easier it was to obtain high aerial gains and adequate obstacle clearance, but meteorological conditions were the more likely to affect propagation. In the United Kingdom radio-relay systems had so far been confined to the 1,700 to 2,300 and 3,300 to 4,200 megacycle bands.

The techniques that might be used on a radio-relay system providing, say, six broad-band channels for television or frequency-division-multiflex telephony required the provision of six base-band input circuits at the transmitting terminal. These led to six broad-band frequency modulated transmitters, the outputs of which passed through combining filters to a common aerial. At a repeater the radio frequency signals, corresponding to the various broad-band channels, were separated, amplified, changed somewhat in frequency and re-combined for transmission over the next section. The frequency was changed to avoid local feed-back from the transmitting to the receiving aerial and to prevent signals from one station being received directly at the next but one station if the sites were more or less in line and propagation conditions were good. At a receiving terminal the radio-frequency signals were separated for the last time, amplified and the base band signal removed.

* * *

DANISH-NORWEGIAN TELEPHONE CABLE

60 *Two-Way Circuits*

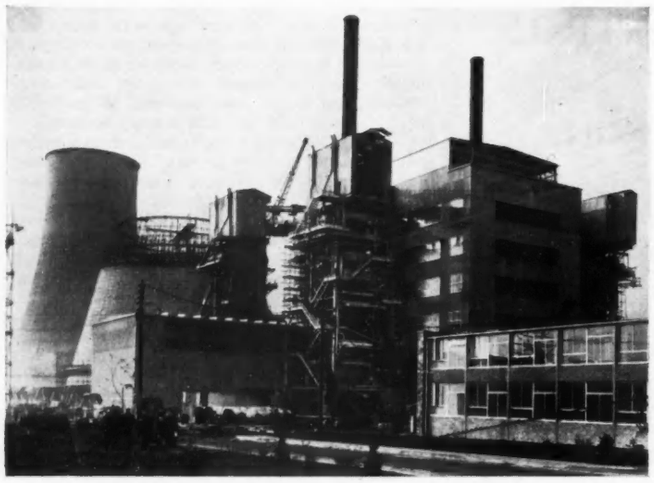
A new submarine telephone cable was laid between Hantsholm in Denmark and Kristiansand in Norway for the Danish and Norwegian Post and Telegraph Administrations by c.s. Ocean Layer on Tuesday, November 8.

This cable, which was manufactured by Submarine Cables Limited, Greenwich, London, S.E.10, is about 70 nautical miles long and will provide 60 simultaneous two-way telephone circuits, carrier frequency bands from 24 to 264 kilocycles and from 312 to 552 kilocycles being used in southwards and northwards directions respectively. The coaxial core of the cable consists of an inner conductor, which comprises a strand of seven 0·0765 in. diameter copper wires round which a tape 0·775 in by 0·015 in. is longitudinally folded, the interior being filled with compound. This construction combines the low direct-current resistance, which is desirable for supplying the repeaters, the transmission efficiency necessary at high carrier frequencies and flexibility. The outer diameter is brought up to 0·935 in. by extruding polythene mixed with 5 per cent. polyisobutylene and a small amount of anti-oxidant on to the conductor.

The outer conductor consists of a layer of six 0·475 in. by 0·015 in. copper tapes which are applied with a long lay and bound by an overlapping short-lay tape 0·004 in. thick. Protection against corrosion is afforded by a Teleconax tape, which is impregnated with a rubber-bitumen-wax compound. To minimise extraneous electrical interference the outer conductor is insulated with Telcothene covered with lead and armoured for ¼ nautical mile at one end and 2·5 nautical miles at the other. A serving of two layers of tarred jute yarn followed by armour, the dimensions of which depends on the depth of laying, is used on the remainder of the cable, which is completed by two layers of tarred jute applied with bituminous compound.

The outer conductors in the shore ends and land cables are insulated with Telcothene and sheathed with lead to assist in the reduction of noise level.

The cable incorporates two submerged repeaters and terminal equipment, which were supplied by Standard Telephones and Cables, Limited, Aldwych, London, W.C.2. One of these repeaters is laid at a depth of 50 fathoms in the Skagerrack and the other in a water tank in the basement of the terminal building at Hantsholm.



A view of the Calder Hall nuclear power station showing reactor No. 1 and one of the heat-exchanger columns. The output of station A, which comprises reactors 1 and 2, will be 92 MW, while station B, the foundations of which are already laid, will add a further 92 MW.

Pressure vessel enclosing No. 1 reactor seen from below, shown with lagging and stainless steel sheathing in position. Fabricated from 2 in. steel plate, the vessel is designed to withstand the pressure of the carbon dioxide gas coolant, which also serves as heat-transfer agent.

ORTHODOX ENGINEERING AT CALDER HALL

Techniques in the Construction of a 92 MW Nuclear Power Station

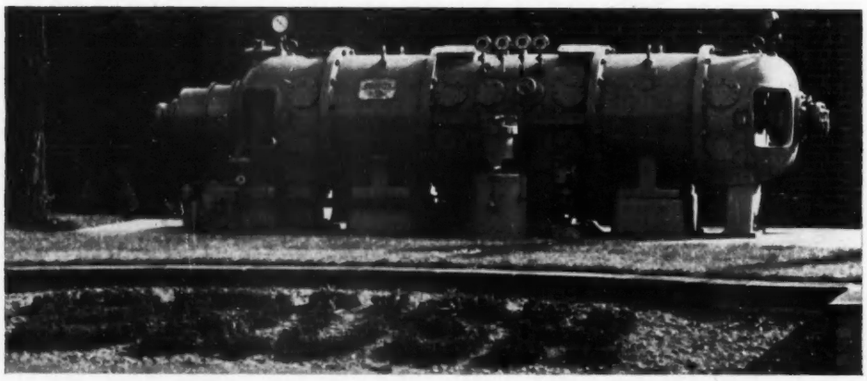
One of the most important conclusions to be drawn from a visit to Calder Hall, the site of the first nuclear power station of any size in the world, is that much of the engineering work involved is of an orthodox nature. In general appearance the buildings are not unlike those of a conventional power station, and many of the construction problems must be similar to those already encountered elsewhere. Admittedly, there are three discrete buildings, two housing reactors and one the turbine plant, but this is mainly a matter of convenience.

The concrete rafts which support the immense weight of the reactors, and the concrete radiation shields, presented problems of an unusual character, but the civil engineers concerned were not without the experience and techniques necessary for solving them. The turbine house —containing four 23 MW turbo-alternator sets— would not perplex any C.E.A. power station superintendent, although he might find the operating pressures and temperatures rather lower than those to which he was accustomed. Pressure vessels much like those used to contain the reactors and carbon dioxide coolant (see right-hand illustration above) have been fabricated for the storage of ammonia and other gases, while the heat exchangers, cylindrical steel vessels 70 ft. high, 18 ft. in diameter and 200 tons in weight (see left-hand illustration above), superficially resemble Ruth's accumulators stood on end. Carbon dioxide at a pressure of 100 tons per square inch has to be circulated and contained, but four 2,000 h.p. fans and 2 in. plate in the 40 ft. diameter 60 ft. high pressure vessels have met this requirement. The cooling towers are larger than is customary (290 ft. high) but are of orthodox construction.

This is not to minimise the great feat of design and construction which has been carried out at Calder Hall, rather it is to emphasise the ingenuity of those responsible, for the work of an engineer is to apply existing techniques to new enterprises and that has been done on an almost unprecedented scale.

The output of station A, which will be supplying electricity to the grid by the end of next year and comprises reactors 1 and 2, will be 92 MW, supplied by four turbo-alternator sets. A further 92 MW will be provided by station B, a mirror image of station A, making a total of 184 MW; its foundations are already laid and it is due to be completed by the end of 1958. The first reactor of station A is likely to be started up for a running-in period in the spring of next year; the second reactor will become critical six months later.

Articles dealing with Calder Hall have already appeared in ENGINEERING (vol. 179, page 240; vol. 180, pages 265, 354, 431 and 490; 1955).



After 39 years trouble-free service, an early Brush-Ljungström steam turbo-alternator set has been presented by the C.E.A. to the makers. Research has shown that the Ljungström principle, which employs radial flow and double rotation of the blading elements, offers scope for future development.

LJUNGSTRÖM TURBINE

Set Presented to Makers after 39 years Service

A Brush-Ljungström turbo-alternator set built by the Brush Electrical Engineering Company, Limited, in 1914 and installed in Loughborough power station in 1915 has recently been presented to the Brush company by the East Midlands Division of the Central Electricity Authority. The set will be on permanent display in the grounds of the company's Falcon Works at Loughborough, where it is shown in the illustration below. Mr. M. Tattersfield, managing director, represented the company at the handing-over ceremony and Mr. W. N. C. Clinch, Controller of the Eastern Division, the C.E.A.

The electrical output of the set was 1,000 kW at full load and 1,250 kW for two hours overload; it ran at a speed of 3,000 r.p.m. During the 39 years it was in service the only major replacements were 10 new blade rings and substitution of Michell type thrust bearings for the original oil dashpots. The Loughborough machine is the oldest Brush-Ljungström turbine in the country, although it was only the second to be built; the first is in service in South Africa.

The Brush-Ljungström turbine, which was originally designed by two Swedish brothers and is a radial-flow steam turbine with additional axial-flow stages in the larger sizes, is characterised by the double rotation of its blading elements. An alternator is bolted at each end of the turbine casing and these are of equal capacity; the turbine is thus located centrally in a symmetrical unit. The two alternators, which rotate in opposite directions, are always in parallel and so remain in synchronism.

About eight years ago, the increasingly onerous conditions of temperature and pressure required for economic operation, and the larger sizes of turbine made necessary by the establishment of the grid, called for radical alterations to the design of the outer rows of radial blading. This modification led to further changes, and considerable research was carried out. As a result of this work the Ljungström principle, which at that time was believed to have reached the limit of its development, is now known to have many years of usefulness ahead, and, as Mr. J. H. R. Nixon, technical director of Brush Electrical observed on the occasion of the presentation, it is now possible to see the lines of further advance. After the ceremony a paper on the evolution of the Ljungström turbine and some recent developments in its design, with special reference to balancing, was delivered by Mr. L. E. Robinson, a designer of the Brush company.

FORTHCOMING EXHIBITIONS AND CONFERENCES

This list, arranged chronologically, appears in the last issue of each month. Events appearing for the first time, and alterations of dates, places, etc., are indicated by an asterisk (*). Particulars of exhibitions and conferences not included below may have appeared in ENGINEERING, *September* 30, *page* 478; *or October* 28, *page* 614. *Organisers are invited to send to the Editor particulars of coming events as soon as arrangements are made.*

Dividing Engines, Exhibition of.—Sat., Oct. 1, for about six months, at the Science Museum, South Kensington, London, S.W.7. Apply to the director of the museum. Tel. KENsington 6371.

***Machine Tool Demonstration.**—Wed., Nov. 23, to Sat., Dec. 3, demonstration of modern machine tools by the Rockwell Machine Tool Co., Ltd., at the Woolston Works of Folland Aircraft Ltd., Hazel-road, Woolston, Southampton. Open week-days from 9.30 a.m. to 5 p.m. and on Saturday from 9 a.m. to 12 noon. Apply to the Rockwell Co., Welsh Harp, Edgware-road, London, N.W.2. Tel. GLAdstone 0033.

British Nuclear Energy Conference, London Meeting.—Wed., Nov. 30, at the Institution of Civil Engineers, Great George-street, London, S.W.1. Symposium of lectures. Attendance is restricted to members of the five institutions participating in the Conference. Information obtainable from the secretary of the Conference, Mr. A. McDonald, 1-7 Great George-street, London, S.W.1. See ENGINEERING, September 9, page 329.

Smithfield Show and Agricultural Machinery Exhibition.—Mon., Dec. 5, to Fri., Dec. 9, at Earl's Court, London, S.W.5. Apply to the exhibition manager, Smithfield Show Joint Committee, 148 Piccadilly, London, W.1. Tel. GROsvenor 4040.

Chemical Industries Exposition.—Mon., Dec. 5, to Fri., Dec. 9, at the Commercial Museum and Convention Hall, Philadelphia, Pa., U.S.A. Organised by the International Exposition Co., 480 Lexington-avenue, New York 17.

Aluminium in Shipbuilding.—Wed. and Thurs., Dec. 7 and 8, at 10 Upper Belgrave-street, London, S.W.1. Joint symposium on "Use and Welding of Aluminium in Shipbuilding," organised by the Institute of Welding, the Institution of Naval Architects, the British Shipbuilding Research Association, the British Welding Research Association and the Aluminium Development Association. Apply to the secretary, Institute of Welding, 2 Buckingham Palace-gardens, London, S.W.1. Tel. SLOane 9851.

***Combustion Engineering Association.**—Thurs. and Fri., Dec. 8 and 9, at the Palace Hotel, Buxton. Theme: "The Years Between." Apply to the Offices of the Association, 6 Duke-street, St. James', London, S.W.1. Tel. WHItehall 5536.

National Boat Show, Second.—Thurs., Dec. 29, 1955 to Tues., Jan. 10, 1956, at Olympia, London, W.14. Organised by the Ship and Boat Builders' National Federation, 205 Regent-street, London, W.1. Tel. REGent 1108.

Indian Science Congress Association, 43rd Meeting.—Mon., Jan. 2, to Sun., Jan. 8, 1956, at Agra. Offices of the Association: 1 Park-street, Calcutta 16, India.

Kitale Air Show.—Fri., Jan. 6, to Sun., Jan 8, 1956, at Kitale, Kenya. Further information obtainable from Captain N.E. Waugh of Harward, Maclachlan & Co., Ltd., P.O. Box 2159, Nairobi, Kenya.

Royal Agricultural and Food Exhibition.—Thurs., Jan. 12, to Thurs., Jan. 26, 1956, at the Ceylon Turf Club, Colombo. Agricultural and dairy machinery exhibits. Organised by the Exhibition Branch, Department of Commerce, P.O. Box 1507, Colombo, Ceylon.

Pakistan Science Congress, Eighth Annual.—Mon., Jan. 16, to Sat., Jan. 21, 1956, at Dacca, East Pakistan. Organised by the Pakistan Association for the Advancement of Science. Apply to Dr. Bashir Ahmad, University Institute of Chemistry, The Mall, Lahore, Pakistan.

New York Lamp Show.—Sun., Jan. 22, to Fri., Jan. 27, 1956, at New Yorker Hotel, New York. Apply to Mr. George F. Little, 220 Fifth-avenue, New York 1. Another Lamp Show will be held on July 8 to 13.

National Plant Maintenance and Engineering Show, Seventh.—Mon., Jan. 23, to Thurs., Jan 26, 1956, at the Convention Hall, Philadelphia. Organised by Clapp and Poliak Inc., 341 Madison-avenue, New York 17, U.S.A.

American Institute of Electrical Engineers, Winter General Meeting.—Mon., Jan. 30, to Fri., Feb. 3, 1956, at New York. Offices of the Institute: 33 West 39th-street, New York 18, U.S.A.

Canadian Hardware and Housewares Exhibition.—Mon., Feb. 6, to Thurs., Feb. 9, 1956, in the Automotive Building, Canadian National Exhibition Grounds, and the Royal York Hotel, Toronto. Information obtainable from Mr. A. P. Wales, Dudley House, Southampton-street, London, W.C.2. Tel. TEMple Bar 8947.

Stationery and Book Trades Fair, National.—Mon., Feb. 6, to Fri., Feb. 10, 1956, at the Royal Horticultural Society's Old and New Halls, Vincent-square and Greycoat-street, London, S.W.1. Organised by the National Newsagent (Exhibitions) Ltd., 149 Fleet-street, London, E.C.4. Tel. CITy 2604.

Stationery Trade Fair.—Mon., Feb. 6, to Fri., Feb. 10, 1956, at Blackpool. Organised by the Stationers' Association of Great Britain and Ireland, 6 Wimpole-street, London, W.1. Tel. LANgham 9256.

Winter Concreting Symposium.—Sun., Feb. 12, to Fri., Feb. 17, 1956, at Copenhagen. Apply to the organising secretary, Rilem Symposium 1956, c/o The Danish National Institute of Building Research, 20 Borgergade, Copenhagen K, Denmark.

***Agricultural Machinery and Equipment Exhibition, 36th International.**—Sun., Feb. 12, to Sun., Feb. 19, 1956, in Brussels. Organised by the Société de Mécanique et d'Industries Agricoles S.A., 29 Rue de Spa, Brussels.

Scottish Dairy Show.—Tues., Feb. 14, to Fri., Feb. 17, 1956, at Kelvin Hall, Glasgow. Organised jointly by the Corporation of Glasgow, and the Glasgow Agricultural Society, Kelvin Hall, Glasgow.

American Institute of Mining and Metallurgical Engineers, Annual Meeting.—Sun., Feb. 19, to Thurs., Feb. 23, 1956, at New York. Offices of the Institute: 29 West 39th-street, New York 18, U.S.A.

Hardware Trades Fair.—Mon., Feb. 20, to Fri., Feb. 24, 1956, at the Royal Horticultural Society's Old and New Halls, Vincent-square and Greycoat-street, London, S.W.1. Apply to the organising secretary, Hardware Trades Fair, 74 Holland Park, London, W.11. Tel. PARk 7723.

Business Efficiency Exhibition.—Mon., Feb. 20, to Sat., Feb. 25, 1956, at Bingley Hall, Birmingham. Organised by the Office Appliance and Business Equipment Trades Association, 11-13 Dowgate-hill, Cannon-street, London, E.C.4. Tel. CENtral 7771.

Radio and Domestic Appliance Exhibition.—Wed., Feb. 22, to Sat., Feb 25, 1956, in the Memorial Hall, Nairobi. Organised by the Radio Traders' Association of East Africa, P.O. Box No. 6742, Nairobi, Kenya.

British Industries Fair.—Wed., Feb. 22, to Fri., Mar. 2, 1956 (including British Toy Fair), at Earl's Court, London, S.W.5. (Organised jointly with British Toy Manufacturers' Association.) Also Mon., April 23, to Fri., May 4, 1956, at Olympia, London, W.14, and at Castle Bromwich, Birmingham. Apply to British Industries Fair, Ltd., 9 Kingsway, London, W.C.2. Tel. COVent Garden 1461; or to general manager, B.I.F., 95 New-street, Birmingham, 2. Tel. Midland 5021.

Modern Gardening Equipment Exhibition.—Thurs., Feb. 23, to Thurs., Mar. 1, 1956, at the Central Hall, Westminster, London, S.W.1. Organised by Universal Exhibitions Ltd., 74 Holland Park, London, W.11. Tel. PARk 7360.

***Automobiles, 15th International Exhibition.**—Fri., Feb. 24, to Sun., Mar. 4, 1956, at Copenhagen. Organised by the Sammenslutningen af Automobilfabrikanter og Importorer, Amaliegade 22, Copenhagen K, Denmark.

Brighton Smallwares Trade Fair.—Mon., Feb. 27, to Fri., Mar. 2, 1956, at the Metropole Hotel, Brighton. Organised by Trade and Technical Exhibitions, Ltd., 1 Dorset Buildings, Salisbury-square, London, E.C.4. Tel. FLEet 1555.

American Society for Testing Materials.—*National Meeting:* Mon., Feb. 27, to Fri., Mar. 2, 1956, at the Hotel Statler, Buffalo, N.Y. *Annual Meeting:* Sun., June 17, to Fri., June 22, 1956, at Atlantic City, N.J. Held in association with the Exhibit of Testing and Scientific Apparatus. *Pacific Coast National Meeting:* Sun., Sept. 16, to Sat., Sept. 22, 1956, at the Hotel Statler, Los Angeles, Calif. Offices of the Society: 1916 Race-street, Philadelphia, Pa., U.S.A.

Frankfurt International Spring Fair.—Sun., Mar. 4, to Thurs., Mar. 8, 1956, at Frankfurt. *Agents:* Lep Transport Ltd., Sunlight Wharf, Upper Thames-street, London, E.C.4. Tel.: CENtral 5050.

Ideal Home Exhibition.—Tues., Mar. 6, to Sat., Mar. 31, 1956, at Olympia, London, W.14. Organised by Associated Newspapers Ltd., New Carmelite House, London, E.C.4. Tel. FLEet 6000.

National Association of Corrosion Engineers.—Mon., Mar. 12, to Fri., Mar. 16, 1956, at New York. Conference. Offices: Southern Standard Building, Houston 2, Texas, U.S.A.

Copenhagen International Fairs.—*Technical:* Fri., Mar. 16, to Sun., Mar. 25, 1956. *Trade:* Fri., April 6, to Sun., April 15, 1956. Apply to the offices, Forchhammersvej 13, Copenhagen V.

American Society of Tool Engineers Exhibition.—Mon., Mar. 19, to Fri., Mar. 23, 1956, in the International Amphitheatre, Chicago. Apply to the American Society of Tool Engineers, 10700 Puritan-avenue, Detroit 21, Mich., U.S.A.

Electrical Engineers (A.S.E.E.) Exhibition, Fifth.—Tues., Mar. 20, to Sat., Mar. 24, 1956, at Earl's Court, London, S.W.5. Organised by Electrical Engineers (ASEE) Ltd., 23 Bloomsbury-square, London, W.C.1. Tel. MUSeum 3450.

Less Common Metals, Symposium.—Thurs., and Fri., Mar. 22 and 23, 1956, in London. Organised by the Institution of Mining and Metallurgy, 44 Portland-place, London, W.1. Tel. LANgham 3802.

Plant and Process Dynamic Characteristics, Conference on.—Wed., April 4, to Fri., April 6, 1956, at the Engineering Laboratory, The University, Cambridge. Organised by the Control Section of the Society of Instrument Technology, 184 Sherwood Park-road, Mitcham, Surrey. (Tel. POLlards 3620). Apply to the secretary, S.I.T. 1956 Conference, Engineering Laboratory, Trumpington-street, Cambridge.

Education of the Young Worker.—Sat., April 7, to Fri., April 13, 1956, at Oriel College, Oxford. Conference organised by the Education Department of the University of Oxford. Apply to the secretary, Young Worker Conference, 15 Norham-gardens, Oxford. Tel. Oxford 58631.

Japan International Trade Fair.—Sun., April 8, to Sun., April 22, 1956, at Osaka. Organised by the Japan International Trade Fair Commission, Honmachibashi, Higashi-Ku, Osaka, Japan.

Factory Equipment Exhibition, Fourth.—Mon., April 9, to Sat., April 14, 1956, at Earl's Court, London, S.W.5. Apply to Mr. J. E. Holdsworth, 4 Snow-hill, Holborn-viaduct, London, E.C.1. Tel. CENtral 0354.

***Radio and Electronic Components.**—Tues., April 10, to Thurs., April 12, 1956, at Grosvenor House, Park-lane, London, W.1. Pre-view for overseas and special guests, Mon., April 9. Annual private exhibition organised by the Radio and Electronic Component Manufacturers' Federation, 21 Tothill-street, London, S.W.1. Applications for admission must be made in advance.

Electrical Association for Women, 31st Annual Conference.—Mon., April 30, to Thurs., May 3, 1956, at Llandudno. Main theme will be "Planning for Light." Apply to the offices of the Association, 25 Foubert's-place, London, W.1. Tel. GERrard 5212.

Domestic Heating in the United Kingdom: Present and Future.—Tues. and Wed., May 1 and 2, 1956, at Church House, Westminster, London, S.W.1. Opening conference of a special study on this subject. Organised by the Institute of Fuel, 18 Devonshire-street, London, W.1. Tel. LANgham 7124.

Mechanical Handling Exhibition, Fifth.—Wed., May 9, to Sat., May 19, 1956, at Earl's Court, London, S.W.5. Organised by *Mechanical Handling*, Dorset House, Stamford-street, London, S.E.1. Tel. WATerloo 3333.

***Association of Supervising Electrical Engineers, Annual Conference.**—Sat. and Sun., May 12 and 13, 1956, at Hastings. Apply to the offices of the Association, 23 Bloomsbury-square, London, W.C.1. Tel. LANgham 5927.

Physical Society's Exhibition of Scientific Instruments and Apparatus.—Mon., May 14, to Thurs., May 17, 1956, at the Royal Horticultural Society's Old and New Halls, Vincent-square and Greycoat-street, London, S.W.1. Organised by the Physical Society, 1 Lowther-gardens, Prince Consort-road, London, S.W.7. Tel. KENsington 0048.

***Strength of Concrete Structures Symposium.**—Wed., May 16, to Fri., May 18, 1956, at the Institution of Civil Engineers, Great George-street, London, S.W.1. Organised, in association with the Joint Committee on Structural Concrete, by the Cement and Concrete Association, 52 Grosvenor-gardens, London, S.W.1. Tel. SLOane 5255. See ENGINEERING, October 28, 1955, page 603.

***British Electrical Power Convention.**—Wed., May 23, to Tues., May 29, 1956, at Torquay. Theme: "Electricity and Transport." Offices of the Convention: Winsley-street, London, W.1. Tel. MUSeum 4040. See ENGINEERING, November 11, 1955, page 672.

Production Exhibition.—Wed., May 23, to Thurs., May 31, 1956, at Olympia, London, W.14. Organised by Andry Montgomery Ltd., 11 Avenue Chambers, 4 Vernon-place, London, W.C.1. Tel. CHAncery 2223.

***Mediterranean Fair, Eleventh.**—Fri., May 25, to Sun., June 10, 1956, at Palermo. Organised by the Fiera del Mediterraneo, Piazza General Cascino, Palermo, Italy.

***Packaging Salon, Fifth International; and 34th International Fair.**—Tues., May 29, to Wed., June 13, 1956, at Padua. *Agents:* Italian Chamber of Commerce for Great Britain and British Commonwealth, 652 Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 5521.

***World Power Conference, Fifth Plenary.**—Sat., June 16, to Sat., June 23, 1956, in Vienna. Organised in Austria by the Oesterreichischen Nationalkomitees der Weltkraftkonferenz, Schwarzenbergplatz 1, Vienna 1. Apply to Mr. C. H. Gray, secretary, World Power Conference, 201-202 Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 3966. See ENGINEERING, February 11, 1955, page 168, and February 25, 1955, page 249.

***Civil Engineering Problems in the Colonies, Conference.**—Mon., June 18, to Fri., June 22, 1956, at Institution of Civil Engineers, Great George-street, London, S.W.1. Apply to the secretary of the Institution at that address. Tel. WHItehall 4577.

***International Association of Bridge and Structural Engineering, Fifth International Congress.**—Mon., June 18, to Sat., June 23, 1956, at Lisbon, Portugal. Apply to Mr. L. Gretener, secretary of the Association, Swiss Federal Institute of Technology, Zürich, Switzerland.

Machine Tool Exhibition, International.—Fri., June 22, to Fri., July 6, 1956, at Olympia, London, W.14. Organised by the Machine Tool Trades Association, Victoria House, Southampton-row, London, W.C.1. Tel. HOLborn 4667.

***Trieste International Trade Fair, Eighth.**—Sun., June 24, to Sun., July 8, 1956, at Trieste. *Agents:* Italian Chamber of Commerce for Great Britain and British Commonwealth, 652 Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 5521.

***Colonial Highways Problems, Round Table Conference on.**—Mon., June 25, to Wed., June 27, 1956, at the Institution of Civil Engineers, Great George-street, London, S.W.1. Organised in conjunction with the Colonial Office. Apply to the secretary of the Institution at the above address. Tel. WHItehall 4577.

***International Union of Forest Research Organisations, 12th International Congress.**—Fri., July 6, to Sat., July 14, 1956, at Oxford. Apply to Professor A. de Philippis, Instituto di Selvicoltura, Piazzale delle Cascine, Florence, Italy.

***Molecules in Cosmic Sources, Seventh International Astrophysical Symposium on.**—Thurs., July 12, to Sat., July 14, 1956, at Liége, Belgium. Apply to Professor Harold C. Urey, Institute for Nuclear Studies, University of Chicago, Chicago 37, Ill., U.S.A.

***International Society of Photogrammetry, Eighth Congress.**—Tues., July 17, to Thurs., July 26, 1956, at Stockholm. Apply to Mr. P. O. Fagerholm, Brageväegen 8, Stockholm, Sweden.

***Housing and Town Planning, International Congress.**—Sun., July 22, to Sat., July 28, 1956, at Vienna. Apply to Mr. H. van der Weijde, secretary-general to the Federation of Housing and Town Planning, Paleisstraat 5, The Hague, Holland.

Australian World's Fair.—Thurs., July 26, to Sat., Aug. 4, 1956, at Sydney. Apply to the managing director, Australian World's Fair, 234 Clarence-street, Sydney, N.S.W., Australia.

***Geographical Congress.**—Thurs., Aug. 9, to Sat., Aug. 18, 1956, at Rio de Janeiro, Brazil. Apply to Mr. G. H. T. Kimble, International Geographical Union, 330 West Forty Second-street, New York 36.

***Radio Show. (23rd Annual National Radio and Television Exhibition).**—Wed., Aug. 22, to Sat, Sept. 1, 1956, at Earl's Court, London, S.W.5. Preview for overseas and special guests, Tues., Aug. 21. Organised by the Radio Industry Council, 59 Russell-square, London, W.C.1. Tel. MUSeum 6901.

***International Society of Soil Science, Sixth International Congress.**—Wed., Aug. 29, to Sat., Sept. 8, 1956, in Paris. Organised by the International Society of Soil Science, Royal Tropical Institute, 63 Mauritskade, Amsterdam, Holland.

***St. Erik's Fair, 14th International.**—Sat., Sept. 1, to Sun., Sept. 16, 1956, at Stockholm. *Agents:* Thirza West Publicity, Ltd., 141 New Bond-street, London, W.1. Tel. MAYfair 3701.

***Leipzig International Autumn Fair.**—Sun., Sept. 2, to Sun., Sept. 9, 1956, Leipzig. *Agents:* Leipzig Fair Agency in Great Britain, 127 Oxford-street, London, W.1. Tel. GERrard 0357.

***Applied Mechanics, Ninth International Congress.**—Wed., Sept. 5, to Thurs., Sept. 13, 1956, at Brussels. Apply to the secretary of the International Committee for the Congresses of Applied Mechanics, Professor F. H. van der dungen, 41 Avenue de l'Arbalète, Boitsfort, Brussels, Belgium.

***High Speed Photography, Third International Congress and Exhibition.**—Mon., Sept. 10, to Sat., Sept. 15, 1956, at Government Offices, Horse Guards-avenue, London, S.W.1. Sponsored by the Department of Scientific and Industrial Research. Apply to the Congress Secretariat, D.S.I.R., Charles House, 5-11 Regent-street, London, S.W.1. Tel. WHItehall 9788. See ENGINEERING, November 11, 1955, page 671.

***"Safe at Work" Exhibition.**—Mon., Oct. 8, to Wed., Oct. 10, 1956, at the Sophia Gardens Pavilion, Cardiff. Organised by the Cardiff and District Industrial Safety Committee of the Royal Society for the Prevention of Accidents. Offices of the Socety: 52 Grosvenor-gardens, London, S.W.1. Tel. SLOane 2246.

***Engineering Industries Association: London Regional Display.**—Wed., Oct. 10, to Fri., Oct. 12, 1956, at the Royal Horticultural Society's New Hall, Greycoat-street, London, S.W.1. Apply to the secretary of the Association, 9 Seymour-street, London, W.1. Tel. WELbeck 2241.

Knitting Machinery and Accessories Exhibition.—Wed., Oct. 17, to Sat., Oct. 27, 1956, at Leicester. Organised by Textile Recorder Exhibitions Ltd., Old Colony House, South King-street, Manchester 2. Tel. Blackfriars 7234.

***Cycle and Motor Cycle Show, 31st International.**—Sat., Nov. 10, to Sat., Nov. 17, 1956, at Earl's Court, London, S.W.5. Organised by the British Cycle and Motor Cycle Manufacturers' and Traders' Union, Ltd., The Towers, Warwick-road, Coventry (Tel. Coventry 62511); and 20-23 Lincoln's Inn Fields, London, W.C.2. Tel. CHAncery 4152.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

BOURNEMOUTH
"Telecommunications," by Major R. J. Jordan. Bournemouth Branch. Grand Hotel, Firvale-road, Bournemouth. Tues., Nov. 29, 8 p.m.
CROYDON
"High-Quality Sound Reproduction," by H. J. Shaw. South London Branch. Half Moon Hotel, Broad Green, Croydon. Thurs., Dec. 1, 8 p.m.
GLASGOW
"Capacitors," by F. Moores. Glasgow Branch. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Wed., Nov. 30, 8 p.m.
LIVERPOOL
"Power-Station Auxiliary Switchgear," by N. D. Peacock. Liverpool Branch. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Fri., Dec. 2, 7.30 p.m.

British Institution of Radio Engineers

LONDON
"High-Fidelity Loud Speakers: The Performance of Moving-Coil and Electrostatic Transducers," by H. J. Leak. London Section. London School of Hygiene and Tropical Medicine, Keppel-street, W.C.1. Wed., Nov. 30, 6.30 p.m.
MANCHESTER
"Latest Developments in Computer Design," by J. J. Moore. North Western Section. College of Technology, Sackville-street, Manchester. Thurs., Dec. 1, 6.30 p.m.

British Interplanetary Society

LONDON
"Probing Interplanetary Space," by E. Burgess. Caxton Hall, Victoria-street, S.W.1. Sat., Dec. 3, 6 p.m.

British Nuclear Energy Conference

LONDON
Inaugural Meeting and Symposium of Lectures. Institution of Civil Engineers, Great George-street, Westminster, S.W.1. Wed., Nov. 30, 2.15 p.m. to 8.15 p.m.* See ENGINEERING, September 9, page 329.

Building Centre

LONDON
Films illustrating uses of copper in building. Wed., Nov. 30, 12.45 p.m.

Chemical Engineering Group

BRISTOL
"Technology of Carbon and Graphite," by J. M. Hutcheon. Bristol Section. Chemical Department, The University, Woodlands-road, Bristol. Thurs., Dec. 1, 7 p.m.

Chemical Society

LONDON
Liversidge Lecture on "Reactions of Radicals in Gaseous Systems," by Dr. E. W. R. Steacie. Royal Institution, 21 Albemarle-street, W.1. Thurs., Dec. 1, 7.30 p.m.
OXFORD
"Why Polymerisation Occurs," by Professor F. S. Dainton. Oxford Branch. Physical Chemistry Laboratory, South Parks-road, Oxford. Mon., Nov. 28, 8.15 p.m.
SHEFFIELD
"Directing Effects in Inorganic Substitution Reactions," by Dr. J. Chatt. Sheffield Branch. The University, Sheffield. Thurs., Dec. 1, 7.30 p.m.

Illuminating Engineering Society

GLASGOW
"Factory Lighting in Practice," by R. K. Christy. Glasgow Centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Thurs., Dec. 1, 6.30 p.m.

Incorporated Plant Engineers

LEEDS
"Gas Turbines in Industry," by J. R. Needham. West and East Yorkshire Branch. The University, Leeds. Mon., Nov. 28, 7.30 p.m.
PETERBOROUGH
"Foundations and Underpinning of Buildings," by F. Pryke. Campbell Hotel, Bridge-street, Peterborough. Thurs., Dec. 1, 7.30 p.m.

Institute of Fuel

CARDIFF
"Wales Gas Board: The Integration of Fuel Supplies," by E. M. Edwards, W. T. Hird, T. S. Ricketts and S. L. Wright. South Wales Section. South Wales Institute of Engineers, Park-place, Cardiff. Fri., Dec. 2, 6 p.m.

Institute of Road Transport Engineers

BRISTOL
"The Development of the Light-Weight Diesel," by Dr. D. J. K. Stuart. Western Centre, Royal Hotel, Bristol. Thurs., Dec. 1, 7.30 p.m.

Institute of Welding

SLOUGH
"Recent Developments in the Argonaut Process," by A. W. Stones. Slough Section. Community Centre, Farnham-road, Slough, Bucks. Tues., Nov. 29, 7.30 p.m.*

Institution of Chemical Engineers

MANCHESTER
"Combustion in Particulate Systems," by L. Cohen. North Western Branch. College of Technology, Manchester. Wed., Nov. 30, 7 p.m.

Institution of Civil Engineers

LONDON
"The Stanchion Problem in Frame Structures Designed According to Ultimate Carrying Capacity," by Dr. M. R. Horne. Tues., Nov. 29, 5.30 p.m.*
BIRMINGHAM
"The Recent Search for and Salvage of the Comet Aircraft, near Elba," by Commander C. G. Forsberg and G. G. MacNeice. Midlands Association. Birmingham and Midland Institute, Paradise-street, Birmingham. Wed., Nov. 30, 6.30 p.m.*

Institution of Electrical Engineers

LONDON
"The Specification of the Properties of the Thermistor as a Circuit Element in Very-Low-Frequency Systems," by Dr. C. J. N. Candy; and "A Vector Method for Amplitude-Modulated Signals," by Dr. C. J. N. Candy. Measurement and Radio Sections. Tues., Nov. 29, 5.30 p.m.*
"TRIDAC: A Large Analogue Computing Machine," by Lieut.-Commander F. R. J. Spearman, J. J. Gait, A. V. Hemingway and R. W. Hynes. Thurs., Dec. 1, 5.30 p.m.*
BIRMINGHAM
"The Recent Search for and Salvage of the Comet Aircraft, near Elba," by Commander C. G. Forsberg and G. G. MacNeice. South Midland Centre. Birmingham and Midland Institute Paradise-street, Birmingham. Wed., Nov. 30, 6.30 p.m.* (Tickets required).
BRIGHTON
"The Breaking of A.C. Circuits and the Short-Circuit Testing of A. C. Switchgear," by Commander E. W. Goodman, R. N. Southern Centre. Brighton Technical College, Brighton. Wed., Nov. 30, 6.30 p.m.
CARDIFF
Faraday Lecture on "Coal Mining Electrically," by B. L. Metcalf. Western Centre. Sophia Gardens Pavilion, Cardiff. Thurs., Dec. 1, 6.30 p.m. (Tickets required).
CHELMSFORD
"Colour Television," by L. A. Harris. London Graduates' and Students' Section. Public Library, Chelmsford. Tues., Nov. 29, 7 p.m.
NEWCASTLE-UPON-TYNE
"The Supply of Electricity in the London Area," by D. B. Irving. North Eastern Centre. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Mon., Nov. 28, 6.15 p.m.

Institution of Engineering Inspection

COVENTRY
"The Wilson Gearbox in Modern Transport," by G. W. Lusty. Coventry Branch. Technical College, Coventry. Tues., Nov. 29, 7.30 p.m.
GLASGOW
"Elements of Quality Control," by A. Kirk. Glasgow Branch. St. Enoch Hotel, Glasgow. Wed., Nov. 30, 7.30 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Fatigue Research at the Mechanical Engineering Research Laboratory," by C. E. Phillips. Tues., Nov. 29, 7.30 p.m.

Institution of Heating and Ventilating Engineers

LONDON
"Glasshouse Heating and Ventilation," by E. R. Hoare and L. G. Morris. Institution of Electrical Engineers, Savoy-place, Victoria-embankment, W.C.2. Wed., Nov. 30, 6 p.m.*
EDINBURGH
"The Heating Engineer and Fuel Efficiency," by H. H. Grattidge. Scottish Branch. 25 Charlotte-square, Edinburgh. Tues., Nov. 29, 7 p.m.

Institution of Highway Engineers

LONDON
"Soil Stabilisation Theory and Practice," by D. J. Maclean. Institution of Structural Engineers, 11 Upper Belgrave-street, S.W.1. Fri., Dec. 2, 5.30 p.m.

Institution of Mechanical Engineers

LONDON
Discussion on "Laboratory Work: Purposes and Methods." Education Group. Tues., Nov. 29, 6.45 p.m.*
"Hydraulic Accumulators in Heavy Industry," by J. G. Frith. Hydraulics Group. Fri., Dec. 2, 5.30 p.m.*
ABERDEEN
"Servo-Mechanisms," by William McHutchison. Scottish Branch. Robert Gordon's College, Aberdeen. Fri., Dec. 2, 7.30 p.m.
CHATHAM
"Mechanical Aspects of the Design of Aircraft Generation Equipment," by W. R. Hinton. Southern Branch. Medway College of Technology, Chatham. Wed., Nov. 30, 7.30 p.m.
GLASGOW
"Servo-Mechanisms," by William McHutchison. Scottish Branch. Royal Technical College, Glasgow. Thurs., Dec. 1, 7.30 p.m.
MANCHESTER
"Co-operation in Engineering Research Between Educational Institutions and Industry": Part I by Professor E. Griffen; Part II by V. C. Davies; and Part III by J. H. R. Nixon. North Western Branch. Engineers' Club, Albert-square, Manchester. Thurs., Dec. 1, 6.45 p.m.

Institution of Production Engineers

BELFAST
"Cutting Tools and Lathe Development," by K. W. Metcalfe. Northern Ireland Section. Kensington Hotel, College-square East, Belfast. Thurs., Dec. 1, 7.30 p.m.
CHELMSFORD
"Production Control of Large Complex Units, in Small and Single Batches," by J. Lees. South Essex Section. Mid-Essex Technical College, Chelmsford. Wed., Nov. 30, 7.30 p.m.
CHELTENHAM
"Induction Heating and Its Application," by D. Jones. Gloucester Section. Belle Vue Hotel, Cheltenham. Thurs., Dec. 1, 7.30 p.m.
READING
"Budgetary Control and Standard Costs," by R. Cutler. Reading Section. Great Western Hotel, Reading. Thurs., Dec. 1, 7.30 p.m.
SHREWSBURY
"Motor-Car Production," by E. Bailey. Shrewsbury Section. Technical College, Shrewsbury. Wed., Nov. 30, 7.30 p.m.
WORCESTER
"Hard Metal Tools," by G. Cook. Worcester Section. Cadena Café, Worcester. Wed., Nov. 30, 7.30 p.m.

Institution of Structural Engineers

LONDON
"The Strength of Concrete-Encased Stanchions," by Dr. Oscar Faber. Joint Meeting with the British Constructional Steelwork Association, Artillery House, Westminster, S.W.1. (Tel. ABBey 2424.) Piccadilly Hotel, 21 Piccadilly, W.1. Tues., Nov. 29, 6.30 p.m. (Tickets required.)
BRISTOL
"Joints in Water-Retaining Structures, with Particular Reference to Reservoirs," by J. A. Young; and "Co-operation Between the Consultant and the Steelwork Engineer," by N. T. A. Beavan. Western Counties Branch. The University, Bristol. Fri., Dec. 2, 6 p.m.
LIVERPOOL
"Concrete as an Engineering Material," by J. Singleton-Green. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Wed., Nov. 30, 6.30 p.m.

Institution of Water Engineers

LONDON
60th Winter General Meeting. "The Construction of a Service Reservoir, Using Colloidal Grout Concrete," by H. Seddon; "The Water Engineer and Cathodic Protection," by K. A. Spencer; and "Some Recent Works in Baghdad," by G. Smethurst. Institution of Civil Engineers, Great George-street, S.W.1. Fri., Dec. 2, 10 a.m.

Manchester Association of Engineers

MANCHESTER
"Vibration," by J. H. A. Crockett. Engineers' Club, Albert-square, Manchester. Fri., Dec. 2, 6.45 p.m.

Royal Aeronautical Society

LONDON
"The Noise of Jet Engines," by F. B. Greatrex. Tues., Nov. 29, 7 p.m.
BOSCOMBE DOWN
"Free Flight Techniques for High-Speed Aerodynamic Research," by P. A. Hufton. Airmen's Mess, Aircraft and Armament Experimental Establishment, Boscombe Down, Hampshire. Thurs., Dec. 1, 6.30 p.m.*

Royal Meteorological Society

LONDON
"Fog and Atmospheric Pollution," by P. J. Meade. County Hall, S.E.1. Thurs., Dec. 8, 5.30 p.m.

The Royal Society

LONDON
Anniversary Meeting. Wed., Nov. 30, 2.30 p.m.

Royal Society of Arts

LONDON
"Science of Brewing"—II, by Dr. A. H. Cook. Mon., Nov. 28, 6 p.m.

Royal Statistical Society

BIRMINGHAM
"The Role of Electronic Computers in Statistics," by Dr. K. D. Toucher. Birmingham Industrial Applications Group. Birmingham Exchange and Engineering Centre, Stephenson-place Birmingham, 2. Wed., Nov. 30, 6.45 p.m.*

Royal United Service Institution

LONDON
"Science in War," by Dr. R. Cockburn. Wed., Nov. 30, 3 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"Production Control Quantometer for Steelworks Analysis," by D. Manterfield and W. Sykes. Engineering Theatre, The University, St. George's-square, Sheffield. Tues., Dec. 6, 7 p.m.

Society of Engineers

LONDON
"Engineering Developments in the Modern Car," by Laurence Pomeroy. Geological Society, Burlington House, Piccadilly, W.1. Mon., Dec. 5, 5.30 p.m.*

Society of Instrument Technology

LONDON
"Electronic Computing Methods," by A. St. Johnston. Manson House, 26 Portland-place, W.1. Tues., Nov. 29, 6.30 p.m.*
FAWLEY
"Future Trends in the Oil Industry," by J. E. Jeffers. Fawley Section. Copthorne House, Fawley, Hampshire. Fri., Dec. 2, 7 p.m.
MIDDLESBROUGH
"The Influence of the Electrical Medium on Instrumentation and Control in Industry," by W. Marchment. Tees-Side Section. Cleveland Scientific and Technical Institution, Corporation-road, Middlesbrough. Thurs., Dec. 1, 7.30 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1. (MUSeum 1901.)
British Interplanetary Society, 12 Bessborough-gardens, London, S.W.1.
British Nuclear Energy Conference, 1–7 Great George-street, Westminster, S.W.1.
Building Centre, 26 Store-street, London, W.C.1. (MUSeum 5400.)
Chemical Engineering Group, 56 Victoria-street, London, S.W.1. (VICtoria 6161.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1. (LANgham 7124.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institute of Welding, 2 Buckingham Palace-gardens, London, S.W.1. (SLOane 9851.)
Institution of Chemical Engineers, 56 Victoria-street, London, S.W.1. (VICtoria 6161.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Inspection, 28 Victoria-street, London, S.W.1. (ABBey 3794.)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. (Central 5181.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Highway Engineers, 47 Victoria-street, London, S.W.1. (ABBey 3891.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1. (SLOane 7128.)
Institution of Water Engineers, Parliament Mansions, Abbey Orchard-street, London, S.W.1. (ABBey 6740.)
Manchester Association of Engineers, 18 Booth-street, Manchester 2. (Central 1717.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Meteorological Society, 49 Cromwell-road, South Kensington, London S.W.7. (KENsington 0730.)
Royal Society, Burlington House, Piccadilly, London, W.1. (REGent 3335.)
Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Royal Statistical Society, 21 Bentinck-street, London, W.1. (WELbeck 7638.)
Royal United Service Institution, Whitehall, London, S.W.1. (WHItehall 5854.)
Sheffield Metallurgical Association, 15 Crescent-road, Sheffield, 7. (Sheffield 53674.)
Society of Engineers, 17 Victoria-street, London, S.W.1. (ABBey 7244.)
Society of Instrument Technology, 184 Sherwood Park-road, Mitcham, Surrey. (POLlards 3620.)

In Parliament

TRAVEL TO LONDON AIRPORT

Monorail transport and the use of helicopters as methods of reaching London Airport were discussed in a series of questions in the House of Commons last week. In reply to Mr. R. G. Page (Conservative), Mr. John Boyd-Carpenter, the Minister of Transport and Civil Aviation, said that the possibilities of a rail or monorail service between central London and London Airport were being examined by a committee composed of officers of the British Transport Commission, the airways Corporations, and his Ministry. He was anxious to obtain the results of those investigations promptly, but the monorail system was not the only possible method.

The Minister told Mr. R. R. Stokes (Labour) that the possibility of providing an underground railway had been raised, but the cost of underground construction was now so high that he did not consider it a likely starter. In answer to Mr. J. W. Snow (Labour), he said that he was certain that the representatives of the airways Corporations on the committee were very familiar with the communications system between Paris and Orly Airport. When Air Commodore A. V. Harvey (Conservative) inquired whether it would not be possible for a body other than the British Transport Commission to be included on the committee, so that a broader view might be obtained of what could be done, Mr. Boyd-Carpenter replied that the point that would arise, if a scheme were put forward, was whether it was remunerative and, if not, who was to pay for it. He thought that that aspect was much better dealt with at the moment by the representatives of the bodies he had mentioned.

With respect to the helicopter service from Waterloo, Mr. Boyd-Carpenter told Mr. John Rankin (Labour-Cooperative) that this experimental unit of British European Airways was operated by the Corporation on his behalf, on payment of a grant. No application to vary the routes which were served at present had yet been made to him. He would no doubt be considering the matter in the next few weeks but, until he had been into the facts, he could not possibly anticipate what the decision would be.

Mr. Boyd-Carpenter had previously told Mr. John MacLeod (National-Liberal), in a written answer, that the helicopter services from Waterloo were not scheduled to connect with particular aircraft and that it was for passengers to decide which one provided the most convenient connection. In the present stage of their development, helicopters were liable, in certain weather conditions and especially in winter, to restrictions on the number of passengers carried and to the cancellation of flights at short notice.

ROAD AND RAILWAY PROGRAMMES

A variety of other questions on transport problems, road, rail and air were answered by Mr. Boyd-Carpenter last week. He told Mr. Gresham Cooke that the total amount provided for new road construction and major improvements in 1954–55 was £5,048,000, of which £4,927,000 was actually spent. The amount provided this year was £8,314,000 and it was expected that that sum would be spent.

So far as schemes authorised were concerned, the total provision made in 1954–55 was £19,360,000, but the value of the schemes actually authorised was £20,027,000. The provision for the schemes to be authorised this year was £29,830,000 and it was expected that schemes to that amount would be authorised. In answer to Mr. G. R. Strauss (Labour), he said that the Government were only too well aware of the problems caused by the very great increase in traffic, actual and potential, over the next few years and of the handicap of the heavy arrears of work with which they were faced.

Mr. Boyd-Carpenter told Mr. Joseph Grimond (Liberal) that capital expenditure on the railways, of which only a small proportion related to the modernisation plan, was estimated at approximately £70 million in the current calendar year and that expenditure on all forms of road construction and maintenance during the current financial year would be of the order of £41 million from central Government funds and around £40 million by local authorities. The road and railway programmes would both go forward not only as to amount but also as to timing.

Answering questions about a proposal to close the Liverpool overhead railway and as what effect it might have upon the safety and flow of goods and passenger traffic in the docks area there, Mr. Boyd-Carpenter said he understood that the Liverpool Overhead Railway Company proposed to promote a Bill during this session to close the railway. Private Bill procedure provided ample opportunity for full examination of issues which arose and he did not think that it was desirable to arrange for another inquiry at that stage.

Scotland to Northern Ireland Tunnel

Mr. Boyd-Carpenter told Mr. H. M. Hyde (Unionist) that he was not prepared to introduce legislation to facilitate the construction of a submarine channel tunnel between the most convenient points connecting Scotland with Northern Ireland. He was asked if he was aware that, when the project was first raised 60 years ago, the engineers and geologists who examined the proposal considered it a perfectly feasible and practical one, and that that opinion had been confirmed by more recent surveys. Mr. Boyd-Carpenter replied that his answer had been based, not on the feasibility or otherwise of the proposal, but on its expensiveness.

Transport of Unusual Loads

A question asked by Mr. W. S. Shepherd (Conservative) as to whether he was aware of the congestion caused by the movement of large pieces of plant and machinery on the roads at peak periods of traffic elicited the reply from Mr. Boyd-Carpenter that vehicles of unusual weight or width were subject to a considerable degree of control under existing regulations. He added that he was going into the question of tightening up this control.

Smoke from Motor Vehicles

Replying to a question from Mr. A. Evans (Labour), Mr. Boyd-Carpenter said he was aware of the difficulties of effectively enforcing regulations 21 and 79 of 1955 concerning the emission of smoke from motor vehicles. He was in consultation with the Home Secretary, Major Gwilym Lloyd-George, as to whether these regulations required revision.

Accidents to Civil Aircraft

In another question, by Mr. Farey-Jones, Mr. Boyd-Carpenter was asked how far he was satisfied that the test of serious negligence, as one of the tests on which he had to decide whether a public inquiry should be held into an accident to a civil aircraft, had proved satisfactory in practice. The test arose under the accident-investigation procedure laid down in paragraph 15 of the Memorandum of the Minister of Civil Aviation dated November, 1948 (H.M.S.O., Cmd. 7564).

Mr. Boyd-Carpenter wrote in reply that he had come to the conclusion that the term " serious negligence " was ambiguous, imprecise and unsatisfactory. He had accordingly asked the Chief Inspector of Accidents to report, in future, whether the preliminary inquiries showed evidence of either (*a*) a reckless disregard for the lives of persons or their safety or that of their property, or (*b*) a high degree of carelessness. These criteria would be substituted for " serious negligence " in assisting him to decide whether a public inquiry was needed.

Grid Lines of 275 kV Voltage

In reply to questions by Major W. W. Hicks Beach (Conservative), Mr. Geoffrey Lloyd, Minister of Fuel and Power, stated that the estimated cost per mile was £25,000 for double-circuit lines with twin conductors of 0·4 sq. in. and a voltage of 275/380 kV; and £16,000 per mile for double-circuit lines with a single conductor of 0·175 sq. in. and a voltage of 275 kV.

As explained in the recent White Paper on nuclear power (H.M.S.O., Cmd. 9389), coal sources of energy would not become redundant within the foreseeable future and, in any case, the grid system would be needed to distribute electricity whether produced from coal or nuclear power.

Hours Worked by Wage Earners

Sir Walter Monckton, Minister of Labour and National Service, informed Mr. John McKay (Labour) that statistics of average weekly hours worked by all men were not available, but inquiries made regarding one week in October, in respect of wage earners in manufacturing industries generally and in a number of non-manufacturing industries, showed that the average hours worked by men aged 21 years and over were 47·7 in 1938; 47·6 in 1946; 46·7 in 1948; and 48·5 in 1954. It was estimated that the number of male employees aged 21 and over in all industries and services in Great Britain was 12,624,000 at the end of May last year. Figures for 1938, 1946 and 1948 were not available.

Censuses of Production and Distribution

In a written answer, Mr. Peter Thorneycroft, the President of the Board of Trade, said that he proposed to defer for a year the programme recommended by the Committee on the Censuses of Production and Distribution, as this would enable a sample survey of distribution to be taken in the form recommended by his advisory committee without increasing the staff engaged on census work. It would mean taking a sample survey of distribution for 1957 instead of 1956, and a full census of production for 1958 instead of 1957; for 1957, a sample census of production would be taken.

Engineering and Technology Students

Answering a question by Mr. Malcolm MacPherson (Labour), Mr. J. Stuart, the Secretary of State for Scotland, wrote that 2,014 students were enrolled for degree or equivalent courses in engineering and technology at technical colleges in Scotland. Of that number, 243 students came from foreign countries.

Technical Assistance Overseas

Mr. Anthony Nutting, Minister of State for Foreign Affairs, stated in a written answer to questions by Mr. Arthur Blenkinsop (Labour) and Mr. N. Nicolson (Conservative) that, subject to the approval of Parliament, the Government proposed to contribute £800,000 in 1956 towards the United Nations' Technical Assistance Programme for that year.

Combine Harvesters

The estimated numbers of combine harvesters in use in Great Britain for the 1954 and 1955 harvests were 25,500 and 29,500, respectively, Mr. D. Heathcoat Amory, the Minister of Agriculture, Fisheries and Food, stated in answer to a question by Sir Leonard Ropner (Unionist).

Coastal Flooding

Mr. Amory informed Commander J. F. W. Maitland (Conservative) that the two recommendations of the Waverley Committee on Coastal Flooding still outstanding, so far as the Ministry of Agriculture, Fisheries and Food was concerned, were financial. Further consideration of them must wait until it could be seen how the finances of the river boards would be affected by rating re-valuation.

Asked whether he would pay particular attention to the making of maintenance grants to the river boards, he said he agreed with the importance which Commander Maitland attached to making sure that damage from coastal flooding did not occur again. He was confident that the arrangements which had been made, the reconstruction which had been carried out, and the future plans of the river boards would provide for that. Sea defences the whole way along the East Coast were much stronger than in 1953.

THE HUMAN ELEMENT

Report on the Civil Service.—Rifts in unions.—Are trade unions monopolies?—Disabled employees.—Old employees.—Post-apprenticeship education for the foreman.

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Technical Officers in the Civil Service

The day when the technical officer, in the widest sense, can present his point of view with the same force to the Treasury as the various clerical and administrative grades has still to come. Judging by the rate at which the Government is becoming forced into an increasing number of technical fields that day may not be very far off. Meanwhile, the technical man is in a weaker bargaining position as a whole than other types of Civil Servant when it comes to matters of salary, pensions and conditions of service.

This comes out in the report of the Royal Commission on the Civil Service which was published last week. The document has been prepared mainly from the point of view of the administrative grade of the Civil Service. There may be good reason for this. The Government has been anxious for some time about its ability to compete with industry for the best non-specialised intellects. In consequence, in proposing increases in many grades, including scientific officers, the problem of recruiting and holding first-rate administrators has received pride of place. This, however, fits in with a basic principle of the Civil Service that the highest posts shall be for administrators who are in many cases promoted out of their specialism. The recommendations for technical salaries broadly involve putting them up by the same amount as corresponding administrative grades.

The Commission hint that the time may come when the comparative grading of technical workers in the Service may have to be raised with the development of specialist work. It may be, however, that developments in atomic energy, automation and the health services, to mention only a few fields, will force the Government to review the basic principles on which it remunerates its specialists. The Royal Commission's report is a tacit admission that the state of the market can be forced to bring this about in due course for any type or grade of Civil Servant.

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Rolls-Royce and Hawker

All is far from well in the ranks of the engineering unions. Rolls-Royce's three Scottish factories have been idle for over three weeks and Hawker's aircraft factory in Blackpool had been strike-bound for nearly ten weeks when work was resumed last Friday. In both cases issues of considerable importance to the trade unions concerned were at stake. A meeting of the Confederation of Shipbuilding and Engineering Unions held in York on November 15, in answer to urgent requests from the men to have their strikes declared official, closed without reaching a decision. Mr. H. G. Brotherton, chairman of the Confederation, said that the issues involved were " so important " that members should have an opportunity for further discussion with their executive committees. There were differences of opinion between the craft unions and the N.U.G.M.W. and the T. & G.W.

The issues were quite different in each case. In Scotland, the strike was started because one man was alleged to be making excessive bonus earnings contrary to a local agreement. In Blackpool, the strike began over the management's refusal to pay night-shift workers a compensatory bonus of 5*d.* an hour. The 2,000 strikers voted to return to work the day after the Confederation's meeting. Workers of one of Rolls-Royce's factories voted to resume work within a few days unless their strike was declared official but they subsequently went back on this.

These stoppages have exposed deep rifts between top union officials and rank and file, and between craft and non-craft unions. The men fought hard and long, at heavy financial loss to themselves. There will be much bitterness at their failure to get support, and an explosive situation will remain.

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Trade Unions and Monopoly

The Government have been asked to amend the Monopolies and Restrictive Practices Act, 1948, to make its provisions applicable to organised labour. In a memorandum submitted to the President of the Board of Trade last week, the Association of British Chambers of Commerce argue that trade unions are actually or potentially as restrictive an influence on the country's industrial growth as trade associations. If protection is to be taken away from goods, then why not from workers? " There is neither equity nor justice in precluding ownership from collective action which may be responsible for unnecessarily high prices while allowing labour, in the same undertaking, to pursue the same course unhampered."

There is one major flaw in the case put forward: people cannot be equated with goods. Unions have grown to protect the lives of millions; they exist to safeguard living standards and in so doing maintain purchasing power. This is not to argue that all unions do is in the national interest, or for that matter always in the interest of their individual members. The rise of splinter unions and the incidence of " unofficial " strikes are evidence enough of the latter. There are instances that the unions have abused their considerable power at the expense of individuals—who, until recently, have had no redress in law (Human Element, November 18: Bonsor *v.* Musicians Unions)—and at the expense of non-members through closed-shop policies. There is also evidence that bigness does not always make for effective leadership.

Much more could be written in criticism of the trade unions. Criticism is healthy, and the more public discussion there is of matters which affect the whole nation, the better. But this is not the same as restricting by law the right to collective bargaining, or equating people with goods. Unfortunately, however, the Association's demands are unrealistic. No British Government could, or would wish to, treat as a collection of monopolies a movement which has become a powerful political force allied with one of the major parties.

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Employing the Disabled

The financial results of Remploy Limited, the Government-subsidised organisation for the disabled, showed a trading loss of £2·7 million compared with £2·5 million in the previous year. Yet the average output per person has risen from £130 a year seven years ago to £450. The company's decision to recruit two more full-time directors, to take over production and sales, suggests that a great deal more can be done to make it economically viable. The chairman, Sir Brunel Cohen, makes it clear that much of the annual loss—which costs the nation £1,135,000 if unemployment, sickness and national assistance benefits that would otherwise have to be paid are taken into account—could be eliminated if funds were available to re-equip Remploy's factories with modern plant and machinery. One of the directors, Mr. George Dowty, chairman of Dowty Seals, said that his company would re-equip Remploy's Southmead, Bristol, factory at the cost of £31,000 and provide the necessary technical know-how to start a new business.

While further progress is doubtless possible, it is open to question whether the disabled are best employed in factories of their own, or individually in manufacturing industry throughout the country, among the able-bodied. The problem is not new—for years the blind have been employed in their own factories and individually in commercial undertakings. Where the latter is possible it is said to be conducive to a more balanced outlook on life and greater personal satisfaction as well as, generally, higher productivity. An extension of the national scheme for the employment of the disabled, where they can work among their fit comrades in normal conditions may be the better solution of a difficult and intensely human problem.

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Older Workers and Their Jobs

Full employment and the growing proportion of the total population in the older age groups continue to keep the problem of the " employability " of older men and women before the public attention. Large organisations, especially public bodies with large clerical staffs, are now continually revising their retirement regulations under constant pressure to find workers or to retain those due to retire without damaging the promotion opportunities of younger people. The London County Council, which claims to be well to the forefront in these matters, has recently further relaxed its age limits under certain conditions.

Mechanisation may bring a higher productivity to the smaller working population which is now being required to carry a growing retired working population, but if this is to be possible it is necessary to focus attention on many industrial problems affecting the ageing worker. Two of these have been receiving attention. The Nuffield Foundation has just published a report called " Ageing in Industry " which goes into the question of how many men have to give up their normal work beyond their mid-sixties. It points out that craftsmen tend to work on but men doing heavy work like stevedoring have to find other jobs. It draws attention to the urgency of this problem for the nation in the case of the face worker in the coal industry.

Another problem, with special relevance to increased mechanisation, is the accident proneness of older men. In the October issue of " Occupational Psychology," Mr. H. F. King has published a paper on " An Age-Analysis of Some Agricultural Accidents." Drawing attention to the inadequacy of available data on this subject, he makes a number of interesting points about age and accidents, including the inference from the statistics that young people get more accidents " on the job " than older men because they are less dexterous; older men have accidents for reasons more indirectly connected with their work.

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Training the Foreman

The thought that the foreman is the N.C.O. of industry has been rather hard worked of recent years but there is a lot of truth in it. There is this to it for instance: that just as the modern N.C.O. has to be treated very often as a specialist, so must the foreman in this age of rapidly increasing mechanisation. Any industries, especially any that are plagued with problems of supervising labour of very mixed efficiency, are to be congratulated when they make an organised attempt to improve the foreman's expertise.

Such a one is the building industry, which has just issued the third report of the National Advisory Committee for the Training of General Foremen. This committee, which has representatives on it from the employers, Ministry of Education, the Institute of Builders and general foremen's associations has set out to describe the development of its certificate course in general foremanship begun experimentally two years ago. In additon to making further progress with formal examinations and so on, lectures are being organised for men already holding responsible positions who, by age, are unsuited for the more formal training which is aimed to attract the younger generation.